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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

INTERROGATOR SET AN/TPX-27 AND IFF MARK X (SIF) SYSTEM (U)

HEADQUARTERS, DEPARTMENT OF THE ARMY WASHINGTON 25, D. C.
AUGUST 1958

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the
115-volt ac circuits and the
300-volt dc circuits.

DON'T TAKE CHANCES

EXTREMELY DANGEROUS VOLTAGES EXIST IN RADIO RECEIVER-TRANSMITTER RT-211/TPX

Voltages as high as 3,500-volts dc are present in this unit.

TECHNICAL BULLETIN
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CHAPTER 1

INTRODUCTION AND DESCRIPTION

Section I. GENERAL

1. Introduction. Interrogator Set AN/TPX–27 is an Interrogator Set AN/TPX–20 that has been modified with MWO 11–1191–1 Modification to convert Interrogator Set AN/TPX–20 to Interrogator Set AN/TPX–27, and to install Recognition Signal Simulator SM–140/TPX and provide Decoder Group AN/TPA–3, Federal stock number 5895–543–1532. The kit includes changes to Interrogator Set AN/TPX–20 to improve the performance of the receiver-transmitter and to facilitate incorporation of Recognition Signal Simulator SM–140/TPX and Decoder Group AN/TPA–3 into the identification friend or foe (IFF) system. When the modification is made, the equipment nomenclature is changed from Interrogator Set AN/TPX–20 to Interrogator Set AN/TPX–27. With the interconnection of the appropriate cabling and the inclusion of Decoder Group AN/TPA–3, the equipment functions as an IFF Mark; X (SIF) (selective identification feature system. Recognition Signal Simulator SM–140/TPX is added to the system for test purposes.

2. Scope. This bulletin contains information and references to information necessary for the operation and maintenance of Interrogator Set AN/TPX–27 and the IFF Mark X (SIF) system. The user of this bulletin must be familiar with Interrogator Set AN/TPX–20, which is covered in TM 11–1191; Decoder Group AN/TPA–3, covered in TM 11–5840–202–10 and TM 11–5840–202–20; and Recognition Signal Simulator SM–140/TPX, covered in TM 11–5840–204–10. This bulletin does not duplicate information contained in other publications except where necessary for clarification.

a. Complete operating procedures for the modified IFF system are included in this bulletin.

b. The maintenance of components is covered by references to other publications, including adjustments, alinements, and replacement of parts where necessary. Technical Manual TM 11–1191 and the technical manuals covering the decoder group and the simulator are required in addition to this bulletin, for installation, theory, and maintenance of Interrogator Set AN/TPX–27 and the IFF Mark X (SIF) system.

c. Circuit changes to the main schematic diagrams of TM 11–1191 which resulted from the equipment modification, are reflected in the partial schematic diagram found at the end of this bulletin.

3. Forms and Records. *a. Unsatisfactory Equipment Reports.*

(1) Fill out and forward DA Form 468 (Unsatisfactory Equipment Report), to the Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700–38.

(2) Fill out and forward AF TO Form 29 (Unsatisfactory Report), to the Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00–35D–54.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment), as prescribed in AF 700–58 (Army), Navy Shipping Guide, Article 1850–4 (Navy), and AFR 71–4 (Air Force).

c. Comments on Literature. Forward all comments on this publication directly to the Commanding Officer, U. S. Army Signal Publications Agency, Fort Monmouth, N. J.

Section II. DESCRIPTION AND DATA

4. Purpose and Use. *a. General.* Interrogator Set AN/TPX–27 is a lightweight interrogator system, designed to be operated in conjunction with Antiaircraft Fire Control System M33 to aid in recognition of friendly aircraft. When properly installed in conjunction with the M33 battery acquisition radar equipment and with Decoder Group AN/TPA–3, Interrogator Set AN/TPX–27

constitutes an IFF Mark X (SIF) system that can transmit coded interrogation signals in the same direction as the rotating battery acquisition radar beam. When a target is detected by the radar system, the interrogator set may be operated to transmit IFF challenge signals to the target. A predesignated IFF reply code will be received from the transponder of the target if the target is friendly and has its equipment turned on. The reply is decoded in Decoder Group AN/TPA–3 and applied to the indicators of the radar to complete the recognition cycle. If the proper reply signal is not received, the target then may be followed by the M33 tracking and fire control system to obtain tactical information for alerted gun batteries.

b. Components of Interrogator Set AN/TPX–27. Interrogator Set AN/TPX–27 consists of the following operating components, physically identical with those shown in figure 2, TM 11–1191. The miscellaneous components are listed in paragraph 9, TM 11–1191.

(1) *Radio Receiver - Transmitter RT–211A/TPX.* The receiver-transmitter is a single, portable unit, comprising the basic IFF radio equipment required for the transmission and reception of coded interrogation signals. The unit consists of a pulse-modulated, 1.5-kilowatt (kw), direct crystal - controlled transmitter which can be varied in frequency from 990 megacycles (mc) to 1,040 mc, and a direct crystal-controlled receiver, capable of receiving pulse-modulated signals over a frequency range of 1,080 mc to 1,130 mc. During operation, the receiver-transmitter is duplexed to the IFF antenna system, and is interconnected with the IFF coder-control unit, the video decoder group, and the special IFF circuits provided by the associated radar.

(2) *Coder-Control, Interrogator Set KY–97B/TPX.* This unit performs the coding functions of the IFF system by processing trigger pulses from the associated radar into suitable coded pulses that initiate operation of the receiver-transmitter unit. In addition, the coder provides the necessary controls for the operation of the receiver-transmitter and incorporates the circuits required for remote operation of the interrogator set.

(3) *Antenna AT–352/UPA–22.* This is a 10-foot broadside array-type antenna that functions both as the transmitting and receiving antenna systems of the interrogator set. The IFF antenna is designed to transmit and receive challenge and reply signals over a frequency range of 1,010 mc to 1,110 mc. It covers a horizontal radiation pattern of less than 7° between half-power points. The instruction literature provided with Antenna AT–352/UPA–22 gives a complete description of this equipment and supplies the detailed antenna information not included in this bulletin.

c. IFF Mark X (SIF) System Components. An IFF Mark X (SIF) system consists of the major operating components listed in (1) through (4) below.

(1) *Interrogator Set AN/TPX–27.* This interrogator set functions with the parent radar, to transmit coded interrogation pulses. Coded replies are received and detected, and the coded video pulse train is applied to the decoder group.

(2) *Decoder Group AN/TPA–3.* The decoder group consists of the video decoder and the remote switching control units. The remote switching control establishes the code for each mode of operation. The video decoder accepts and decodes the coded video pulse train supplied by the receiver system of the interrogator set. A single reply pulse is applied to the radar PPI scope, only when the correct code has been decoded.

(3) *Parent radar.* The interrogator set functions with the parent radar set as described in *a* above. The antenna, receiver-transmitter, and coder-control are located in the search radar antenna pedestal. Primary power, triggers, and return video information are coupled to and from the remaining portions of the IFF system components through slip rings in the antenna pedestal.

(4) *Recognition Signal Simulator SM–140/TPX.* The simulator is not necessary for normal IFF Mark X (SIF) system operation. Its principal function is to provide RF pulse trains or a single RF pulse to the interrogator set receiver-transmitter, to allow for immediate

system checking. It is basically a test equipment unit used with the interrogator set.

5. Equipment Application (figs. 3 and 4, TM 11–1191 and fig. 1, this bulletin). *a. General.* The IFF Mark X (SIF) identification system, comprised principally of Interrogator Set AN/TPX–27 and Decoder Group AN/TPA–3, is intended to aid in recognition of targets detected by its associated radar set. The overall system provides for a ground station interrogator (working in conjunction with a parent radar system), an airborne transponder unit (located in a friendly target) that can reply to a challenge directed from the ground station, and ground-based decoding equipment (interconnected with the interrogator set) to decode the transponder reply signal. Interrogator Set AN/TPX–27 is designed to perform the basic ground station function of the IFF system. It is capable of transmitting a challenge signal to any target detected by the M33 battery acquisition radar, and is able to receive reply signals from suitable friendly airborne transponders. After amplifying and detecting the radio-frequency (RF) reply signals, it applies them to the video decoding group which analyzes the signals for conformance with the reply code that is in tactical use, and delivers the output to the plan-position indicators (PPI) of the associated radar. Since the design of the airborne transponder provides for omnidirectional reception and transmission, the IFF Mark X (SIF) system promotes rapid recognition of any aircraft that comes within the operating range of the parent radar system.

b. IFF Mark X (SIF) Application Characteristics. The successful operation of the IFF Mark X (SIF) system requires that the interrogating station transmit on the same frequency as the receiver system of the airborne transponder and that the transponder unit, conversely, transmit a reply on the same frequency to which the ground station receiver has been tuned. In addition, three challenge modes (or signals) and many variations of the reply code are available, to promote recognition. The three challenge modes that may be transmitted by the interrogator set consist of pulse-pair signals that differ from each other in interpulse spacing. The associated transponder must be adjusted to reply to one or several of the challenge modes with the appropriate coded signal. The three challenge modes are: mode 1, a pulse-pair signal that has an interpulse spacing of 3 microseconds; mode 2, a pulse-pair signal that has an interpulse spacing of 5 microseconds; and mode 3, a pulse-pair signal that has an interpulse spacing of 8 microseconds. The reply coding system is described in TM 11–5840–202–10 for Decoder Group AN/TPA–3. Both the challenge modes and the reply codes are tactical determinations.

c. Installation. Interrogator Set AN/TPX–27 is intended to be operated in conjunction with Antiaircraft Fire Control System M33 to aid in recognition of aircraft detected by radar. The design of the M33 fire control system provides for two cooperative radar units; a tracking radar that is housed in an operating trailer, and a battery acquisition (or search) radar that is installed within the pedestal assembly of the battery acquisition radar antenna. The interrogator set is operated in conjunction with the battery acquisition radar system, and the IFF components are installed within the antenna assembly of the battery acquisition radar. Figures 3 and 4, TM 11–1191, are simplified illustrations showing the relationship of the radar system and the interrogator set.

d. Coordination. In addition to the mounting provided for the IFF equipment, the M33 system provides all circuits and connections required to coordinate the operation of the interrogator set with that of the decoder group and the battery acquisition radar. These provisions include primary power, triggers to synchronize the IFF challenge signals with the transmissions of the battery acquisition radar, visual display equipment to present the IFF reply signals, and remote controls to operate the interrogator set from the M33 fire control trailer. The IFF antenna is rigidly installed on the boom of the battery acquisition radar antenna so that azimuth coordination with the radar antenna is established automatically without the use of auxiliary equipment.

e. Operation. When properly installed in conjunction with the M33 system, Interrogator Set AN/TPX–27 may be operated to challenge any target detected by the battery acquisition radar. This action is initiated by remote control from the tactical (tracking) console in the radar trailer. If the challenged target is equipped with a suitable transponder unit and set for the proper mode and code, an IFF reply signal will be sent to the interrogator set. After being processed by the decoder group (if the SIF feature is employed), the IFF reply signal will appear, together with the radar echo, on the PPI scope of the associated

radar. Outlined in (1) through (6) below is a general description of the operation of the interrogator set based on the simplified functional diagram shown in figure 1. For complete theory of operation, refer to chapter 5.

(1) Triggers from the battery acquisition radar are delivered to the IFF coder-control unit where they are processed into pulse pairs, which carry the coding (interpulse spacing) of one of the three available challenge modes. These pulse pairs are then fed to the receiver-transmitter unit where they initiate transmitter operation and simultaneously establish the reception period (*on* time or *gate* interval) of the IFF receiver system.

(2) In the transmitter system, modulated radio-frequency signals (which carry the selected pulse pairs developed by the coder-control unit) are generated and applied to the IFF antenna system for transmission to any target detected by the associated radar.

(3) If the target detected by the battery acquisition radar is friendly, the IFF challenge signals will be received by the transponder equipment of the target. If it is set for the proper mode and code, the transponder will, in turn, transmit a reply consisting of RF pulses of a predetermined pulse-train configuration (code) at the frequency to which the IFF receiver system has been tuned.

(4) The RF reply signals returning from the transponder are delivered from the IFF antenna to the receiver system in the receiver-transmitter where they are converted into intermediate-frequency (IF) signals, which are detected and amplified.

(5) The reply pulse-trains are fed from the receiver system to the video decoder. Here they are analyzed electronically, to determine whether their pulse configurations correspond to the preselected code. If the code is correct, a single pulse video signal is developed in the video decoder.

(6) The video output of the decoder then is delivered to the video mixing circuit of the associated radar where it is again amplified and applied (together with the radar echo) to the PPI scopes (radar display) in the M33 fire control trailer.

6. Technical Characteristics. The technical characteristics of Interrogator Set AN/TPX–27 are the same as those for Interrogator Set AN/TPX–20 (par. 5, TM 11–1191). In addition to the pulse repetition frequency listed for Coder-Control, Interrogator Set KY–97(*)/TPX (par. 5*c*, TM 11–1191), a maximum output adjustable from 100 to 300 pulse-pairs per second is provided by Coder-Control Unit, Interrogator Set KY–97B/TPX.

Note. The technical characteristics of Decoder Group AN/TPA–3 and Recognition Signal Simulator SM–140/TPX, used with the AN/TPX–27 in the IFF Mark X (SIF) system, are given in TM 11–5840–202–10 and TM 11–5840–204–10, respectively.

7. Packaging Data. *a.* When packaged for export or domestic shipment, the components of Interrogator Set AN/TPX–27 are placed in moisture-vaporproof containers which are packed in four wooden crates. Figure 5, TM 11–1191 illustrates typical packing and packaging of the equipment components.

b. The approximate sizes and weights of the four crates for both export and domestic shipment are given in table I, TM 11–1191. The size and weight of crate number 1 may differ slightly from that given in the table.

c. The contents of the crates are the same as shown in table II, TM 11–1191 except that crate number 1 contains Radio Receiver-Transmitter RT–211A/TPX rather than RT–211/TPX, and Receiver-Transmitter Case CY–944A/TPX rather than CY–944/TPX and also contains Recognition Signal Simulator SM–140/TPX.

Note. Items may be packaged in a manner different from that indicated in *b* and *c* above, depending on the supply channel. Refer to the itemized lists attached to the packing cases for the exact contents of each case.

d. Packaging data for Decoder Group AN/TPA–3 and Recognition Signal Simulator SM–104/TPX (used with Interrogator Set AN/TPX–27 in the IFF Mark X (SIF) system) are contained in TM 11–5840–202–10 and TM 11–5840–204–10, respectively.

8. Nomenclature Assignments. A list of the nomenclature assigned to the components of Interrogator Set AN/TPX–27 is given below, and a common name is given after each item.

Interrogator Set AN/TPX–27	Interrogator set.
Radio Receiver-Transmitter RT–211A/TPX.	Receiver-transmitter.
Frequency Converter-Transmitter Subassembly MX–1376A/UPX–6.	RF subassembly.

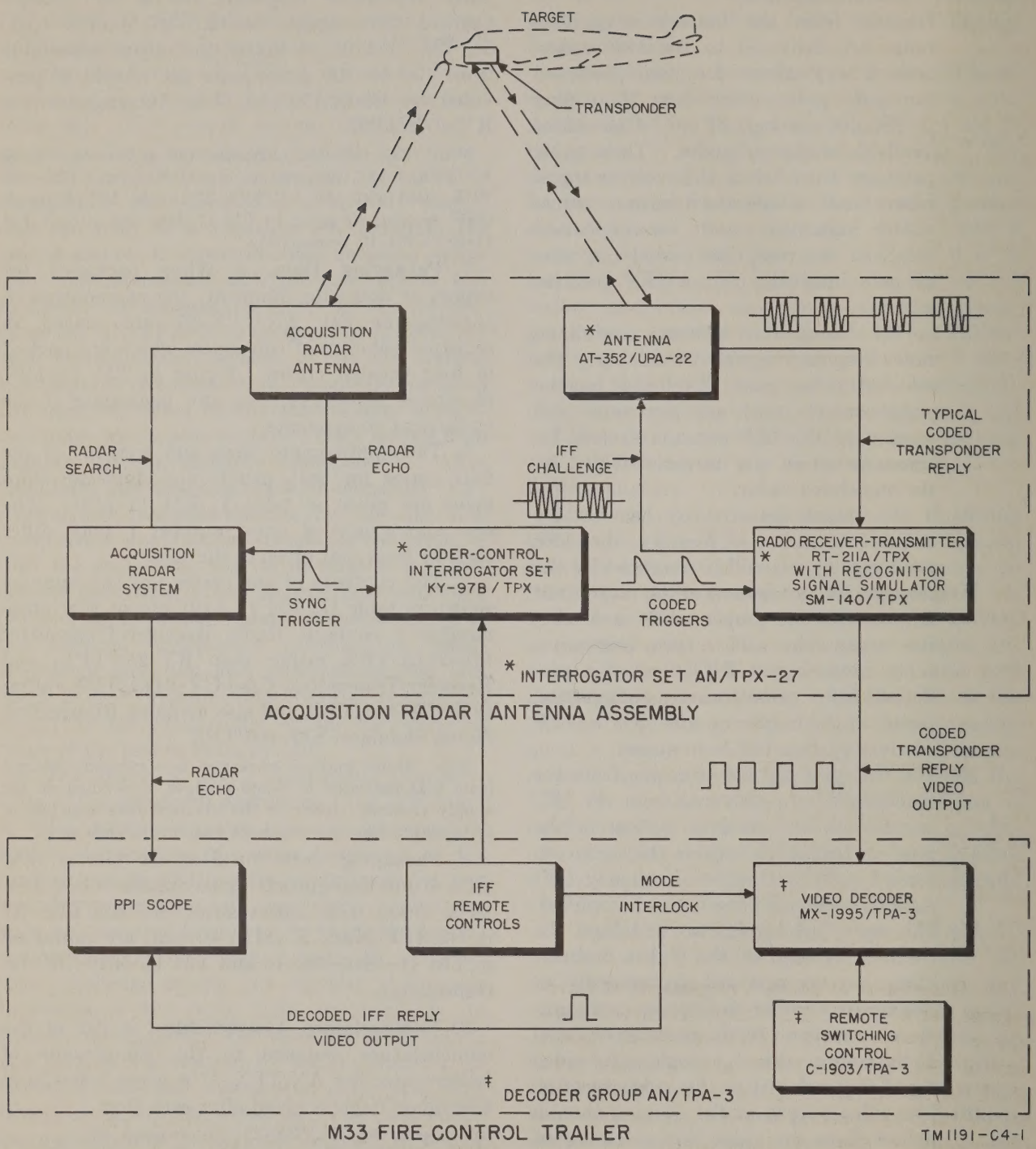

Figure 1. Simplified functional diagram of IFF Mark X (SIF) system employing Interrogator Set AN/TPX-27.

Intermediate Frequency Amplifier AM–761A/TPX.	IF amplifier subassembly.
Coder-Control, Interrogator Set KY–97B/TPX.	Coder-control unit.
Receiver-Transmitter Case CY–944A/TPX (and front cover).	Transmit case for receiver-transmitter.
Electrical Standardized Components Case CY–951/TPX.	Transit case for coder-control unit (and its running spares).
Cotton Duck Bag CW–308/U	Accessories bag.
Antenna AT–352/UPA–22	IFF antenna.
Antenna Case CY–1230/GPA–8.	Transit case for Antenna AT–352/UPA–22.
Electrical Power Cable Assembly CX–1601/TPX.	Special purpose power cables.
Cord CG–278B/U	Antenna cable W701.
Cord CG–409E/U	Trigger cable W702A.
Cord CG–409E/U (0 ft 8 in.)	Simulator RF cable W732.
Cord CG–426D/U (4 ft 8 in.)	Simulator trigger cable W731.
Radio Frequency Cable Assembly CG–1060B/U.	Video cable W702B (extension cable for W702A).
Electrical Power Cable Assembly CX–4442/U.	Control cable W730.
Special Purpose Electrical Cable Assembly CX–2333/U.	Control cable W703B (extension cable for W730).
Connector Adapter UG–274A/U.	T-connector (E403).

9. Weights and Dimensions of Interrogator Set AN/TPX–27 Components. Table III, TM 11–1191, lists the weights and dimensions of the components of Interrogator Set AN/TPX–20. These data are similar for the corresponding components of Interrogator Set AN/TPX–27.

10. Accessories. The same accessories provided with Interrogator Set AN/TPX–20 (par. 9, TM 11–1191) are provided with Interrogator Set AN/TPX–27, with one exception. For Interrogator Set AN/TPX–27, Electrical Power Cable Assembly CX–4442/U (control cable W730) is used in place of Special Purpose Electrical Cable Assembly CX–2286/U (control cable W703A).

11. Description of Major Components of Interrogator Set AN/TPX–27. Radio Receiver-Transmitter RT–211A/TPX, Coder-Control, Interrogator Set KY–97B/TPX, and Antenna AT–352/UPA–22 of Interrogator Set AN/TPX–27 are identical in appearance and function with the corresponding unit of Interrogator Set AN/TPX–20 (pars. 10, 11, and 12, TM 11–1191). Internal modifications have been made to the receiver-transmitter and coder-control units (par. 19).

12. Remote Control Provisions. *a.* The remote control provisions for Interrogator Set AN/TPX–27 are the same as those for Interrogator Set AN/TPX–20 (par. 13, TM 11–1191).

b. Additional remote control facilities are provided when Decoder Group AN/TPA–3 and Recognition Signal Simulator SM–140/TPX are used in combination with Interrogator Set AN/TPX–27 to function as an IFF Mark X (SIF) system. These added facilities are discussed in the publications covering the decoder group, the simulator, and the parent radar equipment.

13. Transit Cases. The transit cases for the equipment are identical with those used for Interrogator Set AN/TPX–20 (par. 14, TM 11–1191), except for Receiver-Transmitter Case CY–944A/TPX. This case is a combination metal-plywood, watertight, transit case designed to hold Radio Receiver-Transmitter RT–211A/TPX. The front and rear covers are removable but are not interchangeable. The deeper front cover is designed to accommodate the receiver-transmitter when Recognition Signal Simulator SM–140/TPX (par. 18*b*) is mounted to its front panel. For operation in any installation other than one providing suitable mounting provisions for the receiver-transmitters, it can be operated within this case with the front and rear covers removed (or left ajar).

14. Interrogator Set AN/TPX–27 Cables and Connectors. Cables and connectors listed in *a* through *i* below that are referenced are common to both interrogator sets (AN/TPX–20, AN/TPX–27). Those not referenced are AN/TPX–27 cables and connectors only. The following cables and connectors are included in each shipment of Interrogator Set AN/TPX–27. These cables provide for the normal operating (or test) connections required between the individual units of the interrogator set; all other cables required to supply power or coordinate the operation of the IFF equipment with the associated radar and the components of Decoder Group AN/TPA–3 are provided by the M33 system (par. 30) or the decoder group (refer to TM 11–5840–202–10 for Decoder Group AN/TPA–3).

a. Cord CG–278B/U. Antenna cable W701 (item 2, fig. 7, TM 11–1191) is a 9-foot, 4-inch length of vinyl-covered coaxial-type cable (RG–9B/U), with male connectors (UG–59A/U) on each end. It is used to connect the receiver-transmitter to the IFF antenna feeder system.

Connection is made at the receiver-transmitter ANTENNA receptacle by right-angle male adapter E212 (UG–212A/U).

b. Cord CG–409E/U Trigger. Trigger cable W702A (item 3, fig. 7, TM 11–1191) is a 34-inch length of vinyl-covered coaxial-type cable (RG–58C/U), with male connectors (UG–88C/U) at each end. It is used to deliver the trigger output of the coder-control unit to the receiver-transmitter.

c. Radio Frequency Cable Assembly CG–1060B/U. Video cable W702B (item 4, fig. 7, TM 11–1191) is an 8-foot length of vinyl-covered coaxial-type cable (RG–58C/U), with a female-type UG–89B/U connector at one end and a male-type UG–88C/U connector at the other end. It is used to extend the length of video cable W702A, when required, for test purposes.

d. Cord CG–409E/U. Simulator RF cable W732 (fig. 2) is an 8-inch length of vinyl-covered coaxial-type cable with a male connector (type UG–88C/U) on each end. It is used to deliver the simulator RF output from the RF OUT jack on the simulator to the RF PROBE 20 DB MID BAND ATTEN connection on the front panel of the receiver-transmitter.

e. Electrical Power Cable Assembly CX–4442/U. Control cable W730 (item 5, fig. 7, TM 11–1191) is a 56-inch, nine-conductor, cold-weather cable with a straight female connector (type AN3106A–24–20S) at one end and a right-angle male connector (type AN3108A–24–6P) at the other end. Mounted to the body of the right-angle connector, just behind the male plug, is a female connector (type AN3102A–12S–3S). The main cable provides the control connections between the coder-control unit and the receiver-transmitter. The small female receptacle on the connector at the receiver-transmitter end is provided for remote operation of Recognition Signal Simulator SM–140/TPX (par. 18) through the coder-control unit when the simulator is installed on the front panel of the receiver-transmitter.

f. Special Purpose Electrical Cable Assembly CX–2333/U. Control cable W703B (item 6, fig. 7, TM 11–1191) is an 8-foot length of 10-conductor, cold-weather cable, with a straight female connector (AN3101A–24–6S) on one end and a right-angle male connector (AN3108B–24–6P) on the other end. It is used to extend the length of control cable W730, when required, for test purposes. However, it does not provide a continuation of the connection between the coder-control unit and the simulator, as does W730. Therefore, when this cable is used, the simulator must be operated locally. Refer to the simulator technical manual for complete operating instructions.

g. Electrical Power Cable Assembly CX–1601/TPX. These cable assemblies (item 9, fig. 7, TM 11–1191) are two 10-foot special purpose cables provided (for test purposes) to supply primary power to the receiver-transmitter and coder-control units in place of the normal operating connections.

h. Cord CG–426D/U. Simulator trigger cable W731 (fig. 2) is a 4-foot, 8-inch length of vinyl-covered, coaxial-type cable with a male connector (type UG–260B/U) on each end. It is used to carry input trigger pulses from the TRIGGER OUT jack of the coder-control unit to the TRIGGER IN connector on the simulator.

i. Connector Adapter UG–274A/U. T-connector E403 (fig. 2) is a T junction connector. When the simulator is installed for system testing, this connector is inserted in the TRIGGER OUT jack of the coder-control unit. Separate trigger output cables are then connected from the two legs of the connector to the TRIGGER IN jacks on the simulator and the receiver-transmitter.

15. Running Spares for Interrogator Set AN/TPX–27. The running spares provided are identical with those listed in paragraph 16, TM 11–1191.

16. Electrical Power Requirements. The receiver-transmitter and coder-control unit are supplied with 117-volt, 400-cycle, single-phase power provided by the M33 radar system. Both these components of the interrogator set are factory-set for normal operating power input, but can be adjusted for 105 or 125 volts by changing the input leads on the appropriate transformers in accordance with the procedures given in paragraph 23, TM 11–1191.

17. Additional Equipment Required. The additional equipment items listed for Interrogator Set AN/TPX–20 in paragraph 18, TM 11–1191 are not supplied with Interrogator Set AN/TPX–27 but are required for proper operation of the equipment.

18. Auxiliary Equipment Items. The equipment discussed in *a* and *b* below are not required for the operation of Interrogator Set AN/TPX–27 but may be used with the interrogator set to increase its efficiency and utility. Decoder Group AN/TPA–3 (*a* below) is used with the interrogator set to permit the equipment to function

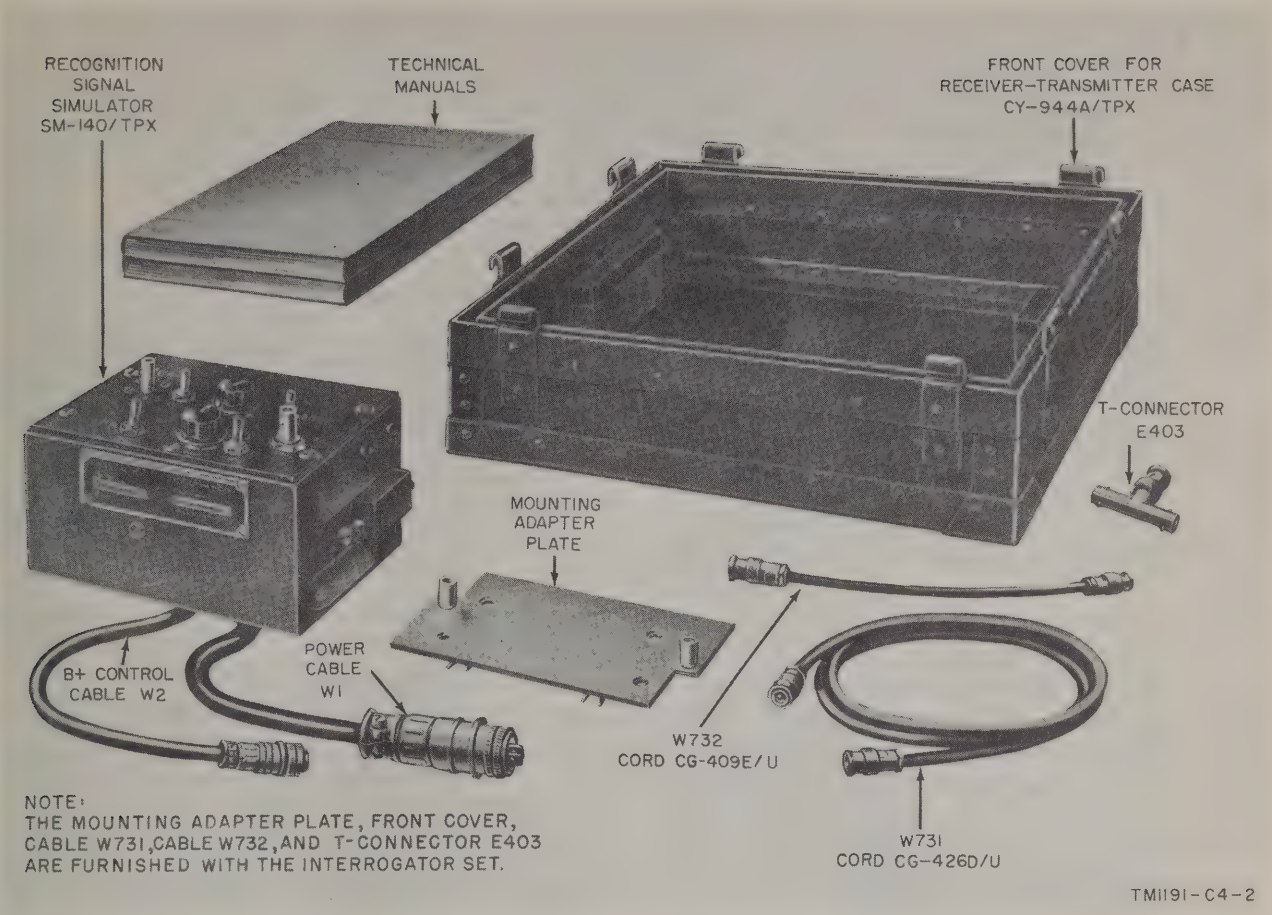
RECOGNITION SIGNAL SIMULATOR SM-140/TPX
TECHNICAL MANUALS
FRONT COVER FOR RECEIVER-TRANSMITTER CASE CY-944A/TPX
T-CONNECTOR E403
MOUNTING ADAPTER PLATE
B+ CONTROL CABLE W2
POWER CABLE W1
W732 CORD CG-409E/U
W731 CORD CG-426D/U
NOTE:
THE MOUNTING ADAPTER PLATE, FRONT COVER, CABLE W731, CABLE W732, AND T-CONNECTOR E403 ARE FURNISHED WITH THE INTERROGATOR SET.
TM1191-C4-2

Figure 2. Recognition Signal Simulator SM–140/TPX, with accessories.

as an IFF Mark X (SIF) system. Recognition Signal Simulator SM–140/TPX (*b* below) is used with the interrogator set as a means to provide a quick check of the overall function of the IFF system.

a. Decoder Group AN/TPA–3. The decoder group consists of two units, Video Decoder MX–1995/TPA–3 (video decoder) and Remote Switching Control C–1903/TPA–3 (remote switching control). The video decoder, when interconnected with the interrogation set, decodes the coded IFF signals that target transponders reply in response to the interrogation set challenge (interrogation) signals. The remote switching control operates to determine which particular coded transponder signals will be decoded by the video decoder in the various modes of operation. The signal coding to be used is predetermined, and the transponders and remote switching control units are adjusted accordingly. The mode of operation used is determined by controls on the tactical control console in the radar equipment trailer.

b. Recognition Signal Simulator SM–140/TPX. Recognition Signal Simulator SM–140/TPX and its accessories (fig. 2) is an auxiliary unit used with Interrogator Set AN/TPX–27. It is designed to mount on the front panel of the receiver-transmitter in place of the holder for the alternate operating crystals. It provides the operator with rapid means to check the functioning of all the components of the system from the remote operating location, without the need for test equipment. When a malfunction is indicated, the simulator controls can be operated at the receiver-transmitter to localize the trouble to the faulty component. In addition, it provides a convenient RF signal source for bench-testing the receiver.

19. Differences in Models. Interrogator Set AN/TPX–27 is an Interrogator Set AN/TPX–20 that has been modified. The differences between Interrogator Set AN/TPX–27 and Interrogator Set AN/TPX–20, and the differences between models of Interrogator Set AN/TPX–20 itself, are described in *a* through *c* below.

a. Receiver-Transmitter. Radio Receiver-Transmitter RT–211A/TPX is identical with Radio Receiver-Transmitter RT–211/TPX, with the following exceptions:

(1) The challenge indicator circuit is modified by the addition of capacitors C142 and C143, diodes CR105 and CR106, and resistor R180 between challenge indicator amplifier V115B and level detector V116. With this modification, the CHALLENGE indicator lamps on the front panel of the receiver-transmitter (and on the remote control units) will light only when the transmitter output is an RF pulse pair (of the proper power), thus providing an indication that the coder-control unit is functioning properly.

(2) Video output transformer T302 in the IF amplifier subassembly has been replaced, resistor R330 and capacitor C329 have been eliminated, and diode CR305 has been inserted in series with the output of the new transformer T302. These changes improve the receiver video output characteristics for pulse-train operation required by IFF Mark X (SIF) coding. The IF amplifier nomenclature is designated Intermediate Frequency Amplifier AM–761A/TPX.

(3) The front-panel frequency adjustment plate and the holder for the alternate frequency operating crystals have been removed to permit installation of Recognition Signal Simulator SM–140/TPX on the panel.

b. Coder-Control.

(1) The design of Coder-Control, Interrogator Set KY–97/TPX of Interrogator Set AN/TPX–20 is changed slightly, beginning with serial number 584. Coder-control units of this serial number and above are designated: Coder-Control, Interrogator Set KY–97A/TPX. In addition to the changes listed in (*a*) through (*e*) below, units having serial numbers 999 through 1,078 contain resistor R461 (10 ohms, ½ watt) connected between pin 5 of chopping relay K403 and ground. The nature of the modification is minor and does not affect the electrical and mechanical interchangeability of these coder-control units.

(*a*) A spare fuse holder and ¾-ampere SPARE fuse is mounted on the rear panel of the unit.

(*b*) The panel marking for the ¾-ampere fuse on the front panel is changed from CONTROL IND. POWER to CODER CONTROL POWER.

(*c*) Impedance-matching link 0 401, on the left side of the inner chassis, is changed as indicated in figures 21 and 167, TM 11–1191.

(*d*) Panel markings on the MODE SELECTOR switch are changed from IFF, PI, and FLI to 1, 2, 3, respectively.

Note. The change in the MODE SELECTOR switch panel markings is not bound by serial number; the former panel marking may be found on coder-control units above serial number 584.

(*e*) In some coder-control units, openings are provided in the louvered side panel so that the COUNT DOWN, CHOP RATE, and TRIGGER DELAY adjustments, mounted on the inner chassis, can be reached.

(2) Coder-Control, Interrogator Set KY–97B/TPX is identical with Coder-Control, Interrogator Set KY–97(*)/TPX with the following exceptions.

(*a*) Capacitor C410 has been changed to 2,700 micromicrofarad ($\mu\mu$f) to reduce the pulse repetition frequency (prf) of the challenge triggers.

(*b*) Additional wiring has been provided between 1 and 7 of chopping relay socket XK403 and pins E and F of RT CONTROL jack J405. The two conductors in control cable W730 which connect to these pins terminate at jack J2 on adapter plate E730, at the receiver-transmitter end of the cable. Simulator cable W2 connects to J2. It is through this connection that the operation of the simulator may be controlled remotely, by use of the CHOP switches on the coder-control and remote control units.

c. Receiver-Transmitter Transit Case. Receiver-Transmitter Case CY–944A/TPX is identical with Receiver-Transmitter Case CY–944/TPX, except that the front cover is deeper to permit the simulator to remain fixed in place on the receiver-transmitter front panel during shipment or storage.

CHAPTER 2

INSTALLATION INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

20. Siting. The siting requirements for Interrogator Set AN/TPX–27 are identical with those given for Interrogator Set AN/TPX–20 in paragraph 20, TM 11–1191. Additional information on the location of the added units required to permit operation of the interrogator set as an IFF Mark X (SIF) system will be found in the literature for the parent radar set.

21. Uncrating, Unpacking, and Checking New Equipment. The uncrating, unpacking, and checking information given in paragraph 21, TM 11–1191 is applicable to Interrogator Set AN/TPX–27. Additional information on the decoder group and the simulator is contained in TM 11–5840–202–10 and TM 11–5840–204–10, respectively.

Section II. PRELIMINARY INSTALLATION PROCEDURES

22. Initial Checks. The initial checks for Interrogator Set AN/TPX–27 are identical with those given for Interrogator Set AN/TPX–20 in paragraph 22, TM 11–1191.

Note. Paragraph 22*a*(2), TM 11–1191, describes the removal of the front-panel cover of Radio Receiver-Transmitter RT–211/TPX. On Radio Receiver-Transmitter RT–211A/TPX of Interrogator Set AN/TPX–27, this cover has been removed to allow for the installation of the simulator.

23. Adjustments and Tuning Procedures. The power supply adjustments, receiver-transmitter tuning and chassis adjustments, and the coder-control unit chassis adjustments given in paragraphs 23 through 26, TM 11–1191, for Interrogator Set AN/TPX–20 also are applicable to Interrogator Set AN/TPX–27.

Section III. INSTALLATION PROCEDURE

24. General. The general installation information given for Interrogator Set AN/TPX–20 in paragraph 27, TM 11–1191 is also applicable to Interrogator Set AN/TPX–27. However, with the addition of Recognition Signal Simulator SM–140/TPX, the cable connectors will differ from those referenced in paragraph 27, TM 11–1191. The simulator is normally installed on the receiver-transmitter before the receiver-transmitter is installed on the radar antenna pedestal. Details on the installation of Decoder Group AN/TPA–3, which may be used with the interrogator set in an IFF Mark X (SIF) system, will be included in the literature covering the parent radar equipment.

25. Coder-control Unit and IFF Mounting Channels Installation. The installation of the coder-control unit on the receiver-transmitter dust cover and the installation of the mounting channels on the dust cover are explained in paragraphs 28 and 29 of TM 11–1191.

26. Installation of Recognition Signal Simulator SM–140/TPX (fig. 3). If Recognition Signal Simulator SM–140/TPX is to be used with the interrogator set, it should be mounted on the receiver-transmitter before installing the receiver-transmitter on the radar set antenna assembly. The simulator is designed to mount on the front panel of the receiver-transmitter immediately in front of the frequency control crystals. Once mounted on the receiver-transmitter, the simulator is intended to remain installed during normal operation of the interrogator set, and during transit or storage of the receiver transmitter. Refer to figure 3 and mount the simulator on the receiver-transmitter according to the instructions in *a* through *d* below.

a. Remove the two thumbscrews that secure the RECEIVER - TRANSMITTER FREQUENCY ADJUSTMENT cover plate and the FREQUENCY CONTROL CRYSTALS AND

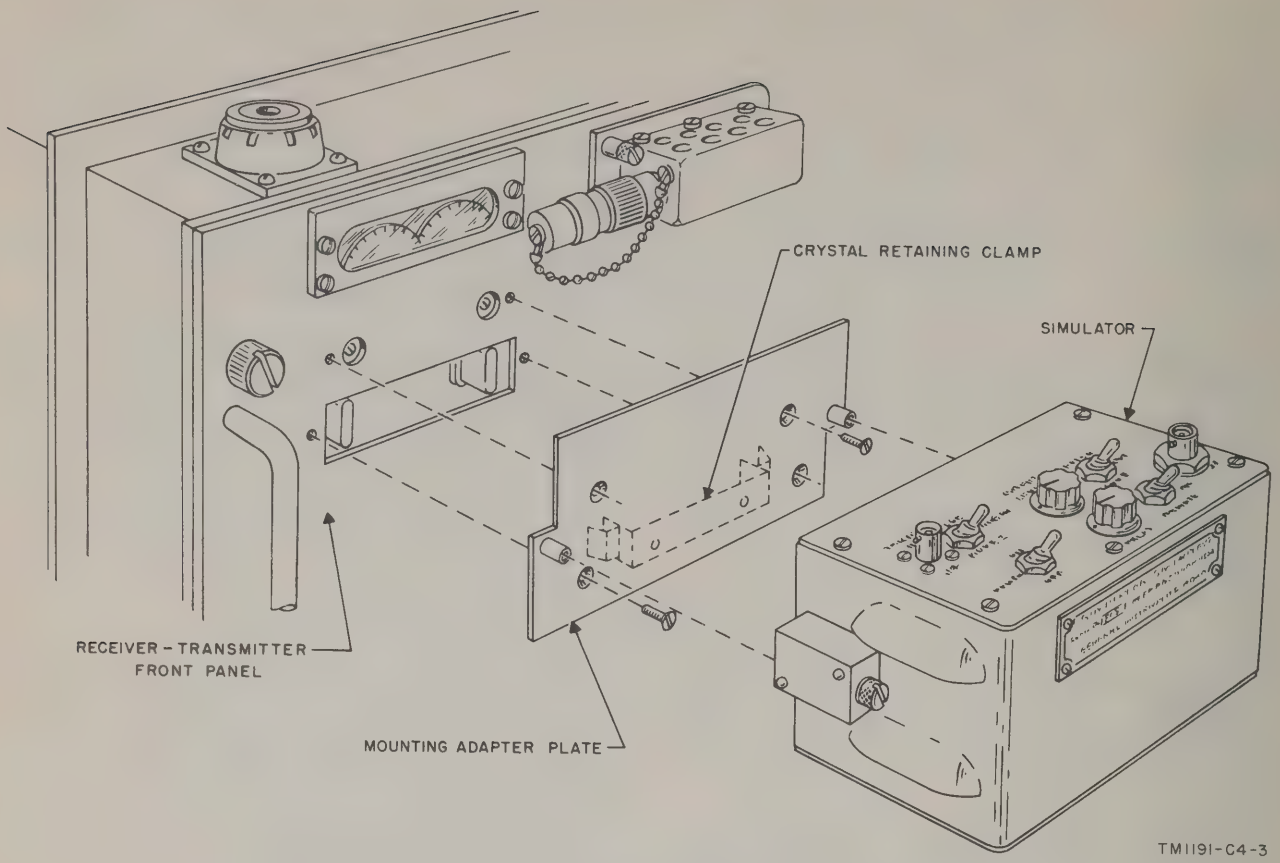

Figure 3. Installation of Recognition Signal Simulator SM–140/TPX.

SPARES cover plate to the front panel of the receiver-transmitter. Remove the screws that secure the captive chain assemblies of these plates. Remove the cap and chain assembly from AC OUT jack J101 on the front panel. Store the two cover plates and the cap and chain assembly in the accessories bag.

b. Place the simulator mounting adapter plate against the front panel of the receiver-transmitter so the two retaining clamps fit over the operating crystals.

c. Secure the mounting adapter plate to the receiver-transmitter with the four No. 8–32 screws. These screws thread into the holes which contained the thumbscrews for the two cover plates removed in *a* above.

d. Mount the simulator to the mounting adapter plate. Thread the two retaining screws into the captive sleeve nuts on the adapter plate.

27. Preliminary Cable Connections. Because the rear panel of the coder-control unit will not be accessible after the equipment units have been installed in the radar set antenna assembly, all cables to this unit must be connected before completing the installation. Lift the receiver-transmitter dust cover (with the coder-control unit and mounting channels attached) to the edge of the inclosed housing provided for the IFF equipment (fig. 22, TM 11–1191). Connect the cables as instructed in *a* and *b* below.

a. Make the following connections of cables from the radar slip ring assembly (fig. 4):

Note. Cable numbers refer to those given in the antenna drive wiring diagram (fig. 5) in TM 9–679B.

(1) Connect plug P13 on cable 27 to TRIGGER IN jack J401 on the coder-control unit.

(2) Connect plug P11 on cable 24 to REMOTE CONTROL jack J404 on the coder-control unit.

(3) Connect plug P12 on cable 25 to POWER IN jack J402 on the coder-control unit.

b. Make the following connections of cables supplied with the interrogator set and the simulator (fig. 4):

(1) Connect the straight female connector (P405) on one end of control cable W730 to RT CONTROL jack J405 on the coder-control unit. Bring the other end of the cable around the side of the coder-control unit so that it can be connected to the front panel of the receiver-transmitter when the main chassis is installed.

(2) Install T-connector E403 (fig. 2) into TRIGGER OUT jack J403 on the coder-control unit. Connect one connector of trigger cable W702A to one receptacle of the T-connector; connect one connector of simulator trigger cable W731 to the other receptacle of the T-connector. Bring the other ends of the cables around the sides of the coder-control unit so that they can be connected to the receiver-transmitter and simulator, respectively, when the main chassis is installed.

28. Installation of Receiver-Transmitter Chassis. After the preliminary cable connections have been made (par. 27), ease the receiver-transmitter dust cover (with the coder-control unit and mounting channels attached) into the housing provided in the radar antenna assembly (fig. 22, TM 11–1191). Insert the captive mounting screws at each end of the mounting channels into the holes provided in the antenna assembly and tighten the screws until the dust cover is mounted securely in the radar antenna assembly. Lift the receiver-transmitter chassis and insert it in the dust cover. Tighten the captive screws on the front panel of the receiver-transmitter until the chassis is seated firmly in the dust cover. The final cable connections to the unit are described in paragraph 30.

29. Installation of IFF Antenna. Procedures for installing the antenna of the interrogator set are given in paragraph 32, TM 11–1191.

30. Final Cable Connections (fig. 4). After the IFF antenna has been installed, the final connection of cables between the components of the interrogator set can be completed. Proceed with these connections as follows:

a. Connect right-angle adapter E212 (item 7, fig. 7, TM 11–1191) to ANTENNA jack J212 on the front panel of the receiver-transmitter.

b. Connect one end of antenna cable W701 (item 2, fig. 7, TM 11–1191) to adapter E212. Connect the other end of antenna cable W701 to the T-junction (low-pass) filter of the IFF antenna.

c. Connect plug P1, on the end of simulator power cable W1, to AC OUT jack J101, on the front panel of the receiver-transmitter.

d. Connect the right-angle connector (P102) on control cable W730 (item 5, fig. 7, TM 11–1191) to REMOTE CONTROL jack J102 on the receiver-transmitter (the other end of control cable W730 was connected to the RT CONTROL receptacle on the coder-control unit as described in paragraph 27*b*).

e. Connect plug P2, on the end of simulator B+ control cable W2, to jack J2 on the right-angle connector of control cable W730.

f. Connect one end of simulator RF cable W732 (fig. 2) to RF OUT jack J3 on the simulator. Connect the other end to RF PROBE 20 DB MID BAND ATTEN jack J213 on the receiver-transmitter.

g. Connect male connector P104A on trigger cable W702A (item 3, fig. 7, TM 11–1191) to TRIGGER IN jack J104 on the receiver-transmitter; connect male connector P4 on cable W731 (fig. 2) to TRIGGER IN jack J4 on the simulator (the other ends of both cables were connected to T-connector E403 at the TRIGGER OUT receptacle on the coder-control unit as described in par. 27*b*).

h. Make the following connections to the receiver-transmitter with the previously installed cables provided by the M33 system:

(1) Connect plug P14 of power cable 26 (from the battery acquisition radar slip ring assembly) to POWER IN jack J116.

(2) Connect plug P5 of video cable 28 (from the battery acquisition radar slip ring assembly) to VIDEO OUT receptacle J103 on the front panel of the receiver-transmitter.

i. Take up the slack in all cables and secure them with the cable straps provided.

31. Cabling Check. The cabling check information given for Interrogator Set AN/TPX–20 in table XI, TM 11–1191 is applicable to Interrogator Set AN/TPX–27 with the following exceptions and added data.

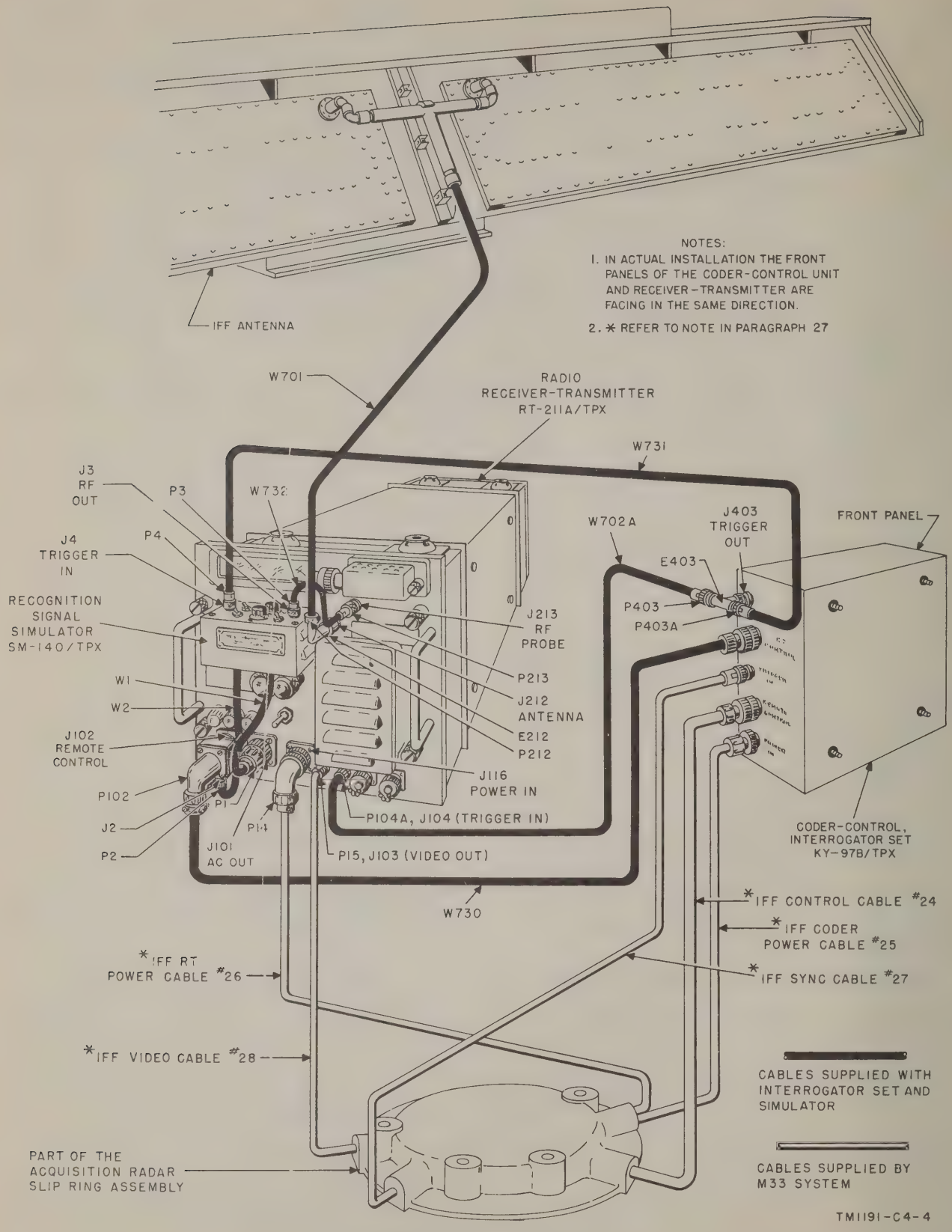

Figure 4. Cabling diagram.

a. When used with Interrogator Set AN/TPX–27, extension video cable W702B connects between coder-control unit TRIGGER OUT jack J403 and the center receptacle of T-connector E403.

b. Cable W703A is replaced by control cable W730.

c. Information to supplement that given in table XI, TM 11–1191, is contained in the chart below.

Cable No.	Nomenclature	Length (ft)	Connects		Remarks
			From	To	
W730	Electrical Power Cable Assembly CX–4442/U.	4⅔	Receiver-transmitter (REMOTE CONTROL J102).	Coder-control unit (RT CONTROL J405).	Permanently connected for normal operation.
W731	Cord CG–426D/U	4⅔	Coder-control unit (TRIGGER OUT J403).	Simulator (TRIGGER IN J1).	Permanently connected for normal operation.
W732	Cord CG–409E/U	⅔	Simulator (RF OUT J3).	Receiver-transmitter (RF PROBE J213).	Permanently connected for normal operation.

32. Installation of Decoder Group AN/TPA–3. Information on the installation of the decoder group in the radar equipment trailer and the interconnection of the decoder group with the radar and IFF systems will be found in the literature related to the parent radar equipment.

33. Connection of Test Cables for Interrogator Set AN/TPX–27. When the interrogator set is installed, it usually is inaccessible for troubleshooting and maintenance. Therefore, special provisions have been made to remove the equipment from the antenna assembly and reconnect it to the acquisition radar system with extension cable assemblies. Instructions are given in paragraph 74*a* for troubleshooting in the receiver-transmitter unit. Follow the procedure given in paragraph 74*b* to make adjustments on the coder-control unit or when both the receiver-transmitter and coder-control unit must be made accessible for testing with radar test equipment.

34. Service Upon Receipt of Used or Reconditioned Equipment. *a.* Follow the instructions given in paragraph 21, TM 11–1191, for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If any changes in wiring have been made, note the changes on the schematic and wiring diagrams in this bulletin and on the applicable diagrams in TM 11–1191.

c. Check the front panel controls to assure ease of operation.

d. Perform the preliminary installation procedures as explained in paragraphs 22 and 23 and the installation procedures outlined in paragraphs 24 through 32.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INSTRUMENTS

35. General. Haphazard operation or improper setting of the controls and misinterpretation of the instruments on the equipment can cause damage and impair its effective operation. For these reasons it is important to know the function of each control and instrument. The actual operating procedures for the equipment are given in paragraphs 41 through 50. Included are the operating procedures for Recognition Signal Simulator SM–140/TPX and Decoder Group AN/TPA–3, which are used with Interrogator Set AN/TPX–27 in the IFF Mark X (SIF) system.

36. Radio Receiver-Transmitter RT–211A/TPX, Controls and Indicators. The principal operating controls on the receiver-transmitter are located on the front panel of the unit. The front panel of the receiver-transmitter is the same as that shown in figure 27, TM 11–1191, except that the RECEIVER - TRANSMITTER FREQUENCY ADJUSTMENT cover and the FREQUENCY CONTROL CRYSTALS AND SPARES cover are removed and the area they occupied is covered by the simulator. The receiver-transmitter controls and instruments and their functions are given in the chart below.

Control or indicator	Function
POWER switch	Connects receiver-transmitter to ac power supply when set to the ON position.
POWER indicator lamp (red).	Lights (after 60-second time delay) when ac power is applied to the receiver-transmitter.
CHALLENGE indicator lamp (green).	Lights when transmitter is operating at normal output level. Light turns off when output level falls below normal.
RECEIVER FREQUENCY and TRANSMITTER FREQUENCY dials.	Direct reading dials manually adjusted to indicate the operating frequency of the transmitter and receiver (see *note* below).

Note. The dial settings are changed by means of the RECEIVER-TRANSMITTER FREQUENCY ADJUSTMENT controls located on the front panel of the receiver-transmitter, behind the mounted simulator.

37. Coder-Control Unit, Interrogator Set KY–97B/TPX Controls and Indicators. The controls and indicators of the coder-control unit are located on the front panel of the unit. The front panel of the unit is identical to that shown in figure 28, TM 11–1191 except that the position notations on the MODE SELECTOR switch are changed from IFF, PI, and FLI to 1, 2, and 3, respectively. The controls and indicators of the coder-control unit and their functions are listed in the chart below.

Control or indicator	Function
POWER switch	Connects ac power to the coder-control unit when set to the ON position.
CHALLENGE switch	Initiates operation of the interrogator set when set to the ON position. This action causes the coder-control unit to begin delivering paired triggers to the receiver-transmitter which activate the transmitter and receiver systems.
CHOP switch	When set to the ON position, connects the chopping circuit which interrupts delivery of trigger pulses to the transmitter. This action will change the appearance of the IFF reply signals on the radar scope as indicated in figures 31 and 32, TM 11–1191. The switch also remotely controls the operation of the simulator (par. 43).
GTC switch	Provides two GTC conditions for observing IFF reply signals. With the switch in the LONG position, false responses due to antenna back and side lobing effects are minimized (par. 45*c*). With the switch in the SHORT position, maximum receiver sensitivity is obtained. The switch normally is set to the SHORT position.

Control or indicator	Function
LOCAL-REMOTE switch.	In LOCAL position, permits operation of the interrogator set from the front panel of the coder-control unit. In REMOTE position, permits operation of the interrogator set from the remote control panel in the radar equipment trailer.
MODE SELECTOR switch.	Three-position switch for selection mode 1, mode 2, and mode 3 operation.
RECEIVER GAIN control.	Controls the gain of the receiver system in the receiver-transmitter.
POWER indicator lamp (red).	Lights when ac power is applied to the coder-control unit.
RT POWER indicator lamp (amber).	Lights (after a 60-second time delay) when ac power is applied to the receiver-transmitter.
CHALLENGE indicator lamp (green).	Lights when the transmitter output is a pulse pair at normal power level. Light goes out when the output falls below normal.

38. Decoder Group AN/TPA–3 Controls and Indicators (figs. 5 and 6). The controls and indicators of the decoder group are located on the front panels of the two equipment units, Video Decoder MX–1995/TPA–3 (video decoder) and Remote Switching Control C–1903/TPA–3. The controls and indicators and their functions are listed in *a* and *b* below.

a. Video Decoder Controls and Indicators (fig. 5).

Control or indicator	Function
POWER switch	In the ON position, connects single phase ac power to the video decoder. Also closes circuit for remote pilot lamps. In the OFF position, removes power from these circuits.
POWER indicator lamp (red) and lamp dimmer control.	Lamp lights when POWER switch is set to ON. A mechanical rotating control around the lamp adjusts to expose the desired amount of light from the lamp.

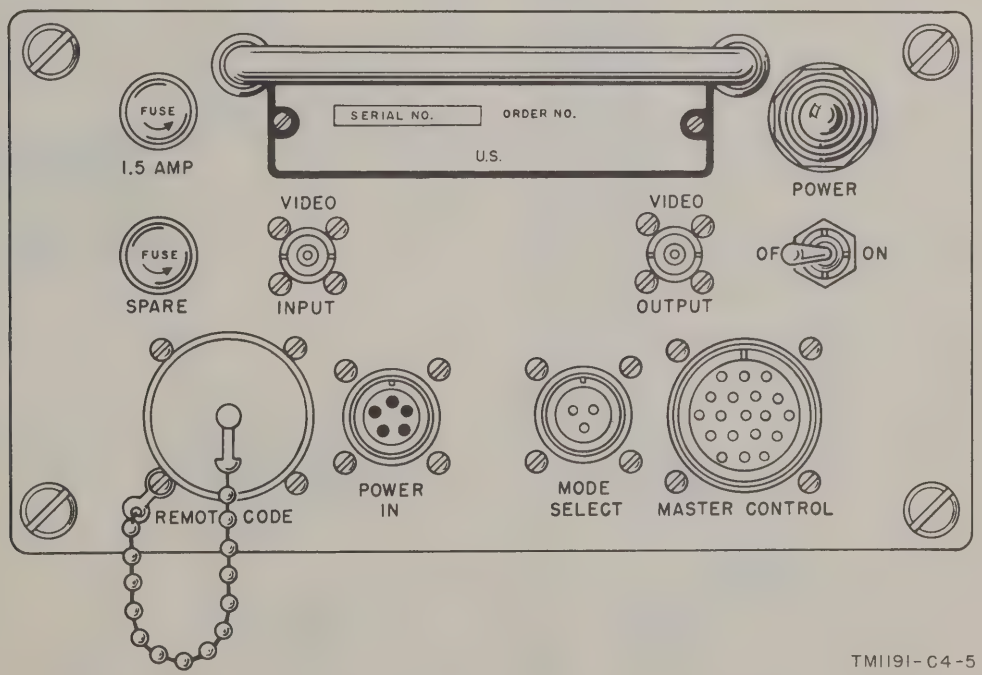

Figure 5. Video decoder operating controls and indicators.

b. Remote Switching Control Controls (fig. 6).

Control	Function	
OPERATE TEST switch.	In TEST position, routes coded pulse trains directly from VIDEO INPUT to VIDEO OUTPUT receptacles, bypassing decoding circuits. In OPERATE position, delivers coded pulse trains to the decoding circuits.	
	Position	*Function*
MODE 1 CODE dual rotary switch.	0, 1, 2, 3 (inner knob) 0, 1, 2, 3, 4, 5, 6, 7 (outer knob).	Selects Mode 1 code setting for video decoder.
	REM (inner knob).	Transfers code setting control of video decoder to auxiliary remote switching control. Switching for remote operation can only be accomplished by the remote switching control connected to the MASTER CONTROL receptacle on the video decoder.
MODE 2 CODE dual rotary switch.	0, 1, 2, 3, 4, 5, 6, 7 (inner and outer knobs).	Selects Mode 2 code setting for the video decoder.
MODE 3 CODE dual rotary switch.	0, 1, 2, 3, 4, 5, 6, 7 (inner and outer knobs).	Selects Mode 3 code setting for the video decoder.

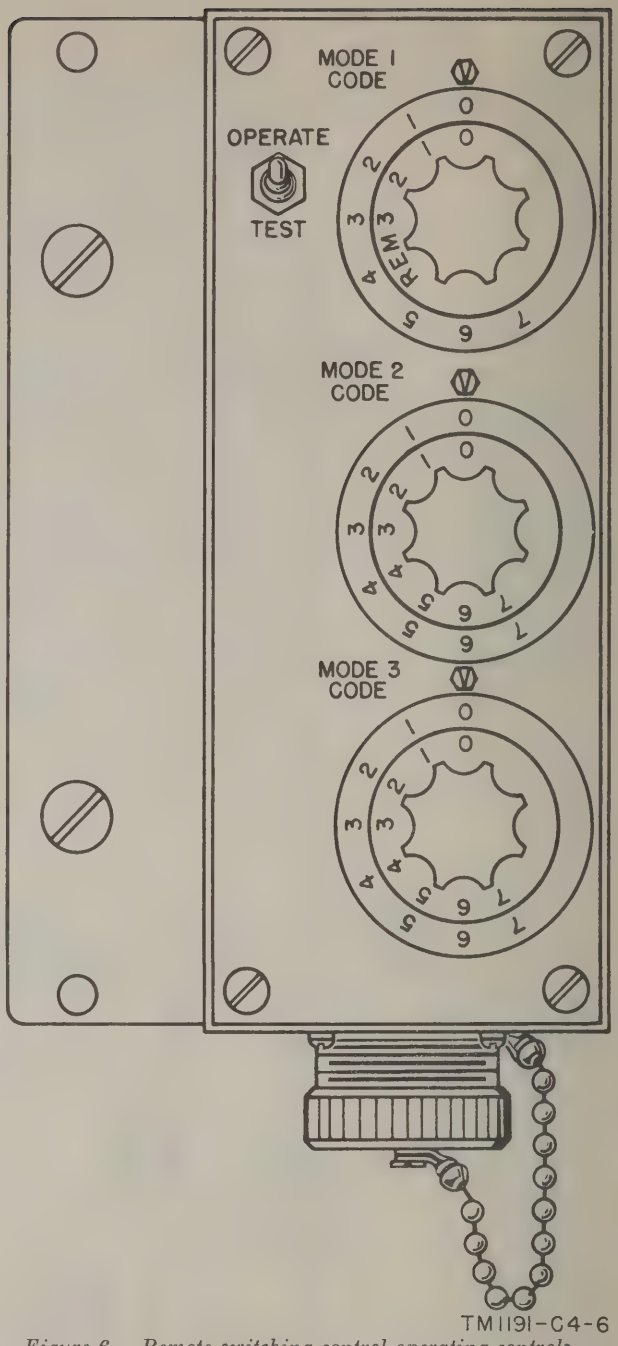

Figure 6. Remote switching control operating controls.

39. Recognition Signal Simulator SM–140/TPX Controls (fig. 7). The operating controls of the simulator are located on the top panel of the unit. The controls and their functions are listed in the chart below.

Control	Function
POWER (ON-OFF) switch.	Connects the simulator to ac power when set to the ON position.
TRIG IN (PULSE MODE 2) switch.	Selects one of two types of input. In the MODE 2 position, it sets the simulator to be triggered by the MODE 2 output from the interrogator set coder-control unit. In the PULSE position, it sets the simulator for operation with any suitable trigger pulse delivered to TRIGGER IN jack J4 on the simulator.
OUTPUT (PULSE CODE) switch.	Selects one of two types of output. In the CODE position, it sets the simulator to deliver a code 77 RF reply signal to the receiver and the video decoder for system testing. In the PULSE position, it sets the simulator to deliver a single RF pulse output suitable for receiver testing.
B+ ON (LOCAL REMOTE) switch.	Provides two methods of controlling the application of B+ power to the simulator circuits. For local operation, the B+ power is applied when the switch is set to the LOCAL position. In the REMOTE position, for system operation, the B+ power is applied to the simulator when the CHOP switch on the interrogator set coder-control unit is set to ON or the CHOP switch on the tactical control console (in the radar equipment trailer) is operated.
OUTPUT LEVEL control.	Adjusts the RF output signal strength (from 0 to −40 dbm maximum) to a level suitable for the IFF receiver.
DELAY control	Adjusts the delay of the simulator output signal from 10 to 100 microseconds (the equivalent of from 1 to 10 miles on the range scale of the radar PPI) with respect to the input triggers.

40. Remote Controls. Two remote control stations are provided in the M33 fire control trailer for the operation of the IFF equipment. The controls at these stations and their uses are discussed in *a* and *b* below. Normally, the equipment will be operated from these remote control stations.

a. Tactical Control Console. The principal IFF remote controls are mounted on the monitor control panel of this console. The control panel is the same as that shown in figure 29, TM 11–1191 with the exception of an added lamp that indicates whether or not power is applied to the

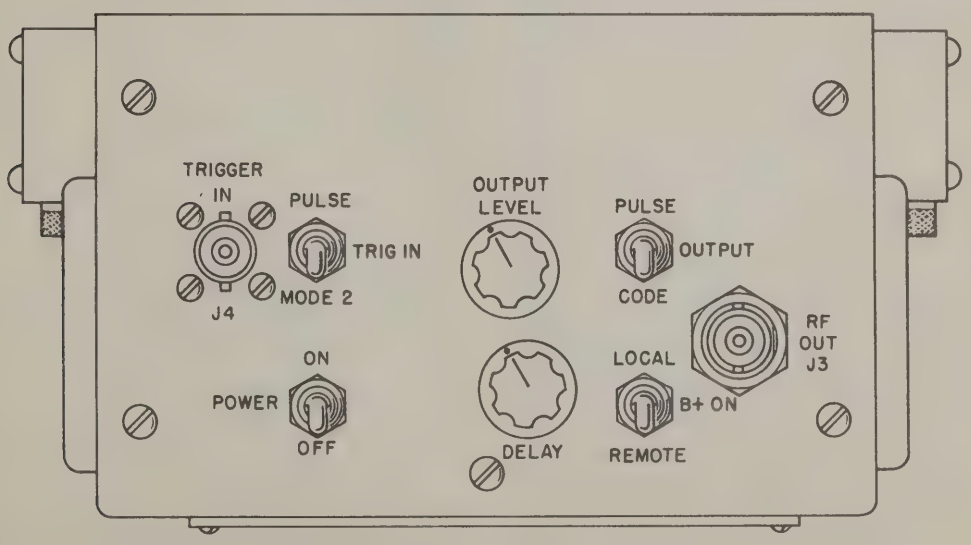

Figure 7. Simulator operating controls.

decoder group and a change of the MODE switch position notations from IFF, PI, and FLI, to 1, 2, and 3, respectively. The IFF controls on this panel duplicate certain operating controls and indicators mounted on the front of the coder-control unit. These controls become operative when the LOCAL REMOTE switch on the coder-control unit is set to the REMOTE position. The following remote controls and indicators are provided: a CHALLENGE switch and CHALLENGE indicator lamp, a MODE SELECTOR switch, a CHOP switch, a GAIN control for the IFF receiver, and a decoder group power indicator lamp. The functions of these controls and indicators are identical with those of the corresponding controls and indicators on the coder-control unit (par. 37) and the video decoder (par. 38*a*).

b. Tracking Console. In addition to the IFF remote control mounted on the tactical control console, three controls and indicators are mounted on the high-voltage indicator power supply panel of the tracking console in the M33 fire control trailer. This panel is shown in figure 30, TM 11–1191. Included on the panel are a CHALLENGE switch and CHALLENGE indicator lamp, and an IFF POWER indicator lamp (which remains lighted when primary power is connected to the IFF equipment). The indicator and controls have the same functions on the corresponding items on the coder-control unit (par. 37).

Section II. OPERATION UNDER USUAL CONDITIONS

41. Preliminary Starting Procedure. Before attempting to operate the equipment, be sure all preliminary adjustments and settings outlined in section II of chapter 2 have been performed. The front-panel controls of the equipment should be set as outlined in the chart below, before the equipment is started. This procedure is for all the components of the interrogator set, simulator, and the decoder group (IFF Mark X SIF) system). Instructions for starting and operating the equipment are given in paragraphs 42 through 50.

Unit	Controls	Position
Receiver-transmitter	POWER switch	OFF
Coder-control	POWER switch	OFF
Coder-control	CHALLENGE switch	OFF
Coder-control	LOCAL-REMOTE switch	REMOTE
Tactical control console	MODE SELECTOR switch	MODE 2*
Tactical control console	GTC switch	SHORT
Tactical control console	CHOP switch	OFF
Tactical control console	GAIN control	Midposition
Video decoder	POWER switch	OFF
Remote switching control	OPERATE-TEST switch	OPERATE
Remote switching control	MODE 2 CODE control*	Code 77*
Simulator	POWER ON-OFF switch	OFF
Simulator	B+ ON LOCAL-REMOTE switch	REMOTE
Simulator	TRIG IN MODE 2—PULSE switch	MODE 2
Simulator	OUTPUT CODE-PULSE switch	CODE

*Controls so noted are for operating check only (par. 43). Mode 2 code 77 is reserved for this purpose. Reset the control in accordance with local tactical operating instructions for normal operation.

42. Starting Procedure. After the controls have been set properly (par. 41), follow the steps given in *a* through *e* below to start the equipment.

a. Turn the receiver-transmitter POWER switch to ON. The POWER indicator on the receiver-transmitter and the IFF POWER indicator on the tracking console should light after a 60-second time delay. The blower in the receiver-transmitter should begin to operate.

Note. Two thermostats are provided in the receiver-transmitter to regulate blower operation. A thermostat causes the blower to stop operating if the temperature inside the equipment falls to about −15° F. (−26° C.). Should the temperature inside rise to 175° F. (80° C.), another thermostat will open, and power will be cut off to all circuits in the unit except the blower system and the AC OUT connector.

b. Turn the simulator POWER switch to ON.

c. Turn the coder-control POWER switch to ON. The POWER indicator on the coder should light.

d. Turn the video decoder POWER switch to ON. The POWER indicator on the video decoder should light and the decoder power indicator lamp on the tactical control console should light.

e. The components of the identification system are now in *standby* condition for test operation. The equipment will begin to transmit interrogation signals and receive replies from the simulator when the CHALLENGE switch is operated at either the tracking console or the tactical control console and the CHOP switch is operated at the tactical control console.

Note. When the LOCAL-REMOTE switch on the coder-control unit is set to the REMOTE position, all front panel operating controls on the coder-control unit are transferred to the remote control panels in the M33 fire control trailer. The CHALLENGE switch may be operated from either the tactical or tracking control consoles. In order to challenge by remote control, the CHALLENGE switch on the coder-control unit must be set to the OFF position.

43. Operating Check. The entire system may be checked immediately to determine its operational status. With all controls set as indicated in the chart (par. 41, see footnote at end of chart), turn the tactical control console CHOP switch to ON and operate the CHALLENGE switch. The CHALLENGE indicator lamps on the receiver-transmitter and the tracking and tactical control consoles should light, indicating normal transmitter operation. If all the components operate satisfactorily, an IFF reply signal originated by the simulator and decoded by the decoder group will appear on the PPI scope of the azimuth-range indicator. A typical IFF reply is shown in figure 31, TM 11–1191. If a malfunction occurs, refer to the equipment performance checklist (par. 57) for troubleshooting procedures and TM 11–5840–202–10 and TM 11–5840–204–10 for additional operational checks for the decoder group and the simulator.

Note. When the simulator B+ ON LOCAL-REMOTE switch is in the REMOTE position, operation of the simulator is controlled by the CHOP switch when the interrogator set is challenging with Mode 2 pulses. Mode 1 or 3 will not trigger the simulator in MODE 2 operation. Refer to TM 11–5840–204–10 for operational check of the simulator.

44. Operating Control Settings. After the equipment has been checked with the simulator, reset the tactical control console MODE SELECTOR switch and the three remote switching control CODE switches in accordance with local tactical operating instructions. The equipment is now in operational readiness and will interrogate radar targets when the CHALLENGE switch is operated.

Caution: **Operate the CHALLENGE switch sparingly, in accordance with tactical standard operating procedures, to prevent overinterrogation of transponders.**

45. Normal Operation. Follow the steps below when operating the interrogator set from the tracking or battery acquisition console.

1. Depress the CHALLENGE switch.
2. Adjust the RECEIVER GAIN control as required.
3. Place the GTC switch in the LONG or SHORT position as required by target range.
4. Place CHOP switch to ON for "chopping" IFF replay (fig. 31, TM 11–1191) or system checking (par. 42).

With the CHALLENGE switch on the tracking or tactical control console depressed, normal operation of the interrogator set will be indicated when the CHALLENGE indicator lamps light and when an IFF reply signal appears on the PPI scopes of the tracking and tactical control consoles. The IFF reply from a friendly target should appear at the same bearing as the radar echo, slightly later in range than the mark or *pip* for the radar target. Figure 31, TM 11–1191 shows a typical IFF presentation on a PPI scope under various conditions or settings of the operating controls outlined in steps 2 through 4 above. The proper adjustment of these controls is discussed in *a* through *c* below. Refer to paragraph 48 for additional adjustments to regulate the operation of the IFF equipment when required.

a. Chopping. When the CHOP switch on the tactical control console is set to the ON position, a chopping circuit in the IFF coder-control unit is activated and periodically interrupts the train of trigger pulses delivered to the receiver-transmitter. The transmitted challenge signals will be interrupted in the same manner. This action will interrupt the reply signals from the target and the IFF reply on the PPI scope will appear as a clearly defined series of dashes (forming an arc) that appear slightly later in range than the radar signal. When the CHOP switch is set to the OFF position, the IFF reply will have the same brilliance, focus, and relative position, but will appear as a solid unbroken arc.

Note. The reply produced by use of the simulator will always appear chopped, because of its interconnection with the chop circuit.

b. Receiver Gain Control. The GAIN control on the tactical control console normally adjusts the level of the signal output from the receiver to the video decoder. Once set above the decoder's threshold level, the GAIN control no longer affects the signal intensity on the radar PPI scope, but will change the level of noise produced by the video decoder. The control should be set for the best signal-to-noise ratio on the PPI scope (sufficiently bright signal return and minimum noise). When the remote switching control TEST-OPERATE switch is in the TEST position, the video decoder is bypassed and the receiver signal is delivered directly to the radar video circuits. During this type of operation the GAIN control may be used to vary the brightness or brilliance of the reply signal. During normal operation (TEST-OPERATE switch in the OPERATE position), the level of IFF signal on the radar scope is adjusted by controls in the video decoder and the associated radar.

Note. The GAIN control may be used to check for proper operation of the receiver system when no signal is obtained from the simulator. Place the remote switching control TEST-OPERATE switch in the TEST position and turn the GAIN control to maximum. If noise appears on the PPI scope (CHALLENGE switch depressed), the receiver system is operating normally. If no noise is obtained, a fault is indicated in the receiver system. Refer to the equipment performance checklist in paragraph 57.

c. GTC Selection. When the GTC switch on the coder-control unit or the tactical control console is in the SHORT position, the receiver has relatively high gain for nearby targets. In the LONG position, the receiver has low gain for nearby targets. For normal operation, the GTC switch is set to the SHORT position. The LONG position is used to eliminate false responses from nearby targets due to antenna side and back lobes. These lobes are present because the antenna also radiates energy at right angles and at 180° to the main lobe. The antenna will pick up responses from targets in the path of these lobes. The effects of side and back lobe responses are shown in figure 134, TM 11–1191. In the upper right-hand sector of the scope is a normal response from the main lobe; that is, the antenna is facing the target. The short solid line is the radar response, while the chopped line is the IFF reply. When the antenna rotates through 90°, the side lobe is directed at the target and a reply is received. However, the response on the PPI indicates the target at 90° from its previous position. When the antenna rotates through 180° from its initial position, the back lobe will be directed at the target; when the antenna rotates through 270°, the other side lobe will be directed at the target. The corresponding responses for the 180° and 270° positions of the antenna are shown at 180° and at 270° from the original response on the PPI scope. The signals from the side and back lobes usually are weaker than the signals from the main lobe. Setting the GTC switch to the LONG position reduces the receiver gain for nearby targets to prevent the side and back lobe responses from appearing on the PPI scope.

Note. The SHORT GATE DURATION and LONG GATE DURATION controls on the receiver-transmitter are factory-set for 720 microseconds. If readjustment to this value is necessary, proceed as follows: Remove the receiver-transmitter from its case and set interlock switch S102 (fig. 109, TM 11–1191) to provide power. Set the LOCAL-REMOTE switch on the coder-control unit to the REMOTE position, the GTC switch on the tactical control console to the LONG position, the decoder remote control TEST-OPERATE switch to the TEST position, and the radar range switch to 120,000 yards. Press the CHALLENGE switch on the tactical control console. Turn the GAIN control on the tactical control console to the maximum position, and adjust the LONG GATE DURATION control on the receiver-transmitter until noise on the PPI scope extends to the end of the sweep. Set the GTC switch on the tactical control console to the SHORT position, and adjust the SHORT GATE DURATION control on the receiver-transmitter in the same manner as the LONG GATE DURATION control. Replace the receiver-transmitter in its case.

46. Challenge Mode and Reply Code Selection. After the operating control settings have been made, the interrogator set will transmit interrogation signals in the same direction as the battery acquisition radar signal whenever the CHALLENGE switch on the tracking or tactical control console is depressed. The mode, or coding, of the signal transmitted is controlled by the MODE SELECTOR switch on the tactical control console. The decoder will decode and pass only those reply signals with codes that agree with the setting established by the coding controls on the remote switching control panel. These coding controls are interlocked with the MODE SELECTOR switch on the tactical control console, so that the mode selection automatically determines which of the coding controls will be effective.

47. Local Operation. The equipment cannot be normally operated from the coder-control unit (LOCAL-REMOTE switch to LOCAL), because the mode interlock feature (which selects the

proper mode switch on the remote switching control) is only provided on the tactical control console. The only exception is the CHALLENGE switch, when operated as an emergency provision. The coder-control unit CHALLENGE switch may be used to initiate interrogator set operation instead of using the tactical control or tracking console CHALLENGE switches, *but only if the LOCAL-REMOTE switch is in the REMOTE position and all other remote switching control switches (including the decoder remote control switches) are set properly.* For testing or trouble-shooting purposes the interrogator set may be operated from the coder-control, but the decoder group will not be operational in the system at this time. Refer to paragraph 33 for test connection.

48. Regulating IFF Reply Signal. In addition to the operating controls provided for the IFF equipment, certain adjustments may be made to regulate the appearance of the reply signal on the radar PPI scope. These adjustments cannot be made by remote control and must be regulated, as required, at the specific unit involved.

Caution: **Before attempting to make any of the adjustments given below, make certain that the antenna drive switch on the radar antenna assembly is turned to the OFF position.**

a. Chop Rate Control. The CHOP RATE control (R436) on the right side of the coder-control unit chassis should be adjusted if the IFF reply signal initiated either by the simulator or a transponder does not appear as a series of dashes when the CHOP switch is set to the ON position (fig. 33, TM 11–1191). To make this adjustment, turn off the acquisition radar equipment and remove the receiver-transmitter dust cover (with the coder attached) as described in paragraph 33. Remove the louvered side panel of the coder-control unit and locate CHOP RATE control R436 (fig. 21, TM 11–1191). (In some equipments, the side panel need not be removed because an access hole is provided.) Loosen the locknut on this control and turn R436 in either a clockwise or counterclockwise direction to change the chopping rate. Replace the IFF equipment for normal operation and start the acquisition radar equipment. Observe the IFF reply signal on the radar scopes in the fire control trailer to see if the adjustment has had the desired effect. If the proper setting has not been obtained, refer to figure 33, TM 11–1191 to see whether the control has been set too high or too low. If the control has been set too low, the signal will appear as a solid unbroken arc without the desired chopping action. If the control is set too high, the signal will appear as a series of closely spaced dots. Repeat the above procedure, as required, until the desired chopping action is observed on the scope.

b. Trigger Delay Control. The TRIGGER DELAY control (R411), on the right side of the coder-control inner chassis (fig. 21, TM 11–1191), may be adjusted to change the distance the IFF reply and the radar signal on the PPI scope if the two signals cannot be distinguished readily. To make this adjustment, remove the coder-control unit as described in *a* above and remove the louvered side panel of the unit. Set the DELAY IN-DELAY OUT switch (fig. 21, TM 11–1191) to the DELAY IN position. The spacing from the IFF reply signal to the radar signal then may be regulated by loosening the lock out on the TRIGGER DELAY control and adjusting the control as desired. Replace the IFF equipment for normal operation and start the acquisition radar equipment. Observe the IFF reply signal on the radar scopes to see if the proper adjustment has been obtained. Repeat the above procedure as required until the proper result has been obtained. Make certain that the control is locked securely after making each adjustment.

Note. The interrogator set normally is operated with the DELAY IN-DELAY OUT toggle switch set to the DELAY OUT position. This provides for a fixed delay between the radar signal and the IFF reply. The above adjustment should be made only if a greater spacing, or interval, is desired between the two signals on the radar scopes.

c. Video Limiting Control. The video limiting control (R325) on the left side panel of the receiver-transmitter (fig. 20, TM 11–1191) is factory-set for normal operation, but it may be readjusted for a particular installation. To make such an adjustment, turn the antenna drive switch to the OFF position, and remove the receiver-transmitter chassis from its dust cover. Set interlock switch S102 on the rear of the chassis (fig. 9, TM 11–1191) to provide power, and replace the chassis partially within the dust cover. The control normally is set at the extreme clockwise position for maximum video output. To adjust, or limit, the video output level, turn the control slowly counterclockwise until the desired level is observed on the PPI scopes in the operating trailer. After making the adjustment, replace

the receiver-transmitter chassis in the dust cover; the interlock switch will automatically be reset for normal operation. Secure the captive screws on the front panel of the unit.

49. Stopping Procedure. Under normal conditions, the IFF equipment will turn off automatically whenever the battery acquisition radar system is turned off. With this action, the CHALLENGE indicator of the tactical control console and the CHALLENGE and IFF POWER indicators on the tracking console will turn off. When the interrogator set is turned off in this manner, the equipment will start again (after a 60-second time delay) whenever the battery acquisition radar equipment is turned on. As an auxiliary method, the IFF equipment can be turned off locally by turning the POWER switches on the front panels of the receiver-transmitter and coder-control unit to the OFF position.

Caution: **Before attempting to turn off the interrogator set locally, make certain that the antenna drive switch on the radar antenna assembly is turned to the OFF position.**

50. Special Operating Provisions. In addition to the information given in paragraphs 45 through 48 for regulating the appearance of the IFF reply signal, the following adjustments may be required for certain installations.

a. Countdown Adjustment. When an aircraft equipped with a transponder flies through a high traffic area (a region where many interrogator sets are in operation), the transponder equipment may easily become overinterrogated. When this happens, circuits in the transponder operate to cut down the reply rate, and distant interrogators may not receive a reply to their challenge signals. Therefore, it is important to adjust the coder COUNT DOWN control (R431) in each interrogator set to prevent interrogation at too high a rate. This control should be adjusted to its minimum setting consistent with satisfactory equipment performance. (Instructions for the setting of this control are given in par. 227, TM 11–1191.)

b. Power Attenuator. In certain installations, spurious responses resulting from the IFF antenna side lobes will not be eliminated completely by operation of the GTC switch (par. 45*c*). When this is the case, it may be necessary to utilize the power attenuator mounted on the front panel of the receiver-transmitter (fig. 34, TM 11–1191). Proceed as follows:

(1) Release the two captive screws that hold the attenuator to the front panel; remove the unit.
(2) Unscrew the dummy load on the left side of the unit.
(3) Remove the existing antenna cable connection to adapter E212 at ANTENNA jack J212 of the receiver-transmitter.
(4) Insert the connector on the rear of the POWER ATTENUATOR into adapter E212.
(5) Reconnect the antenna cable to the receptacle on the left side of the power attenuator.
(6) The receiver-transmitter now is reconnected in series with the IFF antenna system through the power attenuator.

c. Antijamming. If interference signals appear on the radar scope, turn off the IFF equipment to determine whether the interference is reaching the scope through the IFF equipment or through the radar set. If the interference disappears when the IFF equipment is turned off, it is coming through the IFF equipment. If it is suspected that the interference is being produced by jamming, try both narrow- and wide-band operation (par. 90*c*, TM 11–1191). Use the operation that affords the minimum jamming effect.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

51. General. Operation of the equipment may be difficult in regions where extreme cold, heat, humidity, or sand conditions prevail. Special procedures regarding operation and maintenance of the equipment are required under these adverse conditions. Paragraph 52 contains references to information on the operation of the equipment under unusual conditions.

52. Procedures for Operation Under Unusual Conditions. *a.* Paragraphs 47 through 49 of TM 11–1191 contain information on the operation of the interrogator set in arctic, tropical, and desert areas.

b. Information on operation under unusual conditions is contained in paragraphs 33 and 34, TM 11–5840–202–10 for the decoder group and in paragraphs 25 through 28, TM 5840–204–10, for the simulator.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

53. Tools and Materials. Paragraphs 50 and 51, TM 11–1191 list the tools supplied with the interrogator set and the tools and materials required for maintenance.

54. Preventive Maintenance Services. Paragraphs 52 through 55, TM 11–1191 give the purpose, techniques, forms to be used, and the performance of preventive maintenance for the interrogator set. Paragraphs 57 and 58, TM 11–1191 give weatherproofing, rustproofing, and painting procedures.

Section II. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

55. Organizational Maintenance Troubleshooting. Paragraphs 59 and 60 of TM 11–1191 give general information for troubleshooting at organizational maintenance level. The following should be used as aids for detail troubleshooting of the IFF Mark X (SIF) system.

a. The equipment performance checklist (par. 57).

b. The simulator to check the operation of the system (par. 43).

c. System sectionalization of trouble to a component (par. 56).

d. Detailed wiring diagram of interconnecting cables (fig. 8).

56. System Sectionalization to a Component. System sectionalization consists of determining whether the trouble is in the transmitter, receiver, coder-control, decoder group, antenna system, or the associated IFF video and trigger circuits of the radar equipment.

a. Operate the simulator and observe the performance of the interrogator set and decoder group. Refer to the equipment performance checklist (par. 57) for normal operating indications.

b. If the entire interrogator set is dead, the trouble is in either the power supply or the power cable.

c. If the CHALLENGE indicator lamps do not light but the simulator operates (simulated IFF reply signal appears on the PPI scope), the trouble is in the transmitter. If the simulator does not operate, the fault is likely to be in the coder-control or interconnecting trigger cables.

d. If both the interrogator set and the simulator do not operate when the EXT TRIGGER-SELF TRIGGER switch on the coder-control unit (fig. 21, TM 11–1191) is set to the EXT TRIGGER position, but both units operate when the switch is set to the SELF TRIGGER position, the fault is in the radar set, the coder-control unit, or the trigger cable between them.

e. If the equipment is challenging properly, but no reply signal appears on the PPI scope, the trouble may be in either the receiver or the video decoder. If a pulse train appears on the indicator when the decoder remote control TEST-OPERATE switch is in the TEST position, the trouble is in the video decoder. If a signal still does not appear, the trouble is in the receiver or interconnecting cables.

f. If the equipment is challenging properly, but a weak or distorted reply is received, the trouble may be in the coder-control circuits that regulate the appearance of the IFF signal or in the receiver GTC system. Refer to figures 31 and 33, TM 11–1191 for IFF presentations.

g. If the failure cannot be traced to one of the components of the interrogator set or decoder group, the fault may be in either the slip ring assembly or the IFF synchronization and video circuits of the radar system. If no challenge signal is indicated (all CHALLENGE indicator lamps out), the fault is likely to be in the cable connection from the synchronization circuit to the TRIGGER IN jack on the coder-control. If the reply signal is not regulated properly in amplitude, the fault may be in the video circuit of the radar, in the video decoder, or in the cable connection from the receiver-transmitter VIDEO OUT jack to the video decoder and radar video circuits.

h. By using procedures similar to the checks above, the trouble can be isolated to a particular unit. In addition to the information given in the equipment performance checklist (par. 57), refer to the troubleshooting procedures in chapter 6, TM 11–1191 and to instructions for the use of the simulator when troubleshooting the interrogator set (TM 11–5840–204–20). For cabling information, refer to the installation diagram (fig. 4) and the detailed wiring diagram (fig. 8).

57. Equipment Performance Checklist.

Note. Exact nomenclature of receptacles and connectors is given in the chart in paragraph 31. When it is necessary to follow the procedure listed in the corrective measures column, use the test cables connections given in paragraph 33.

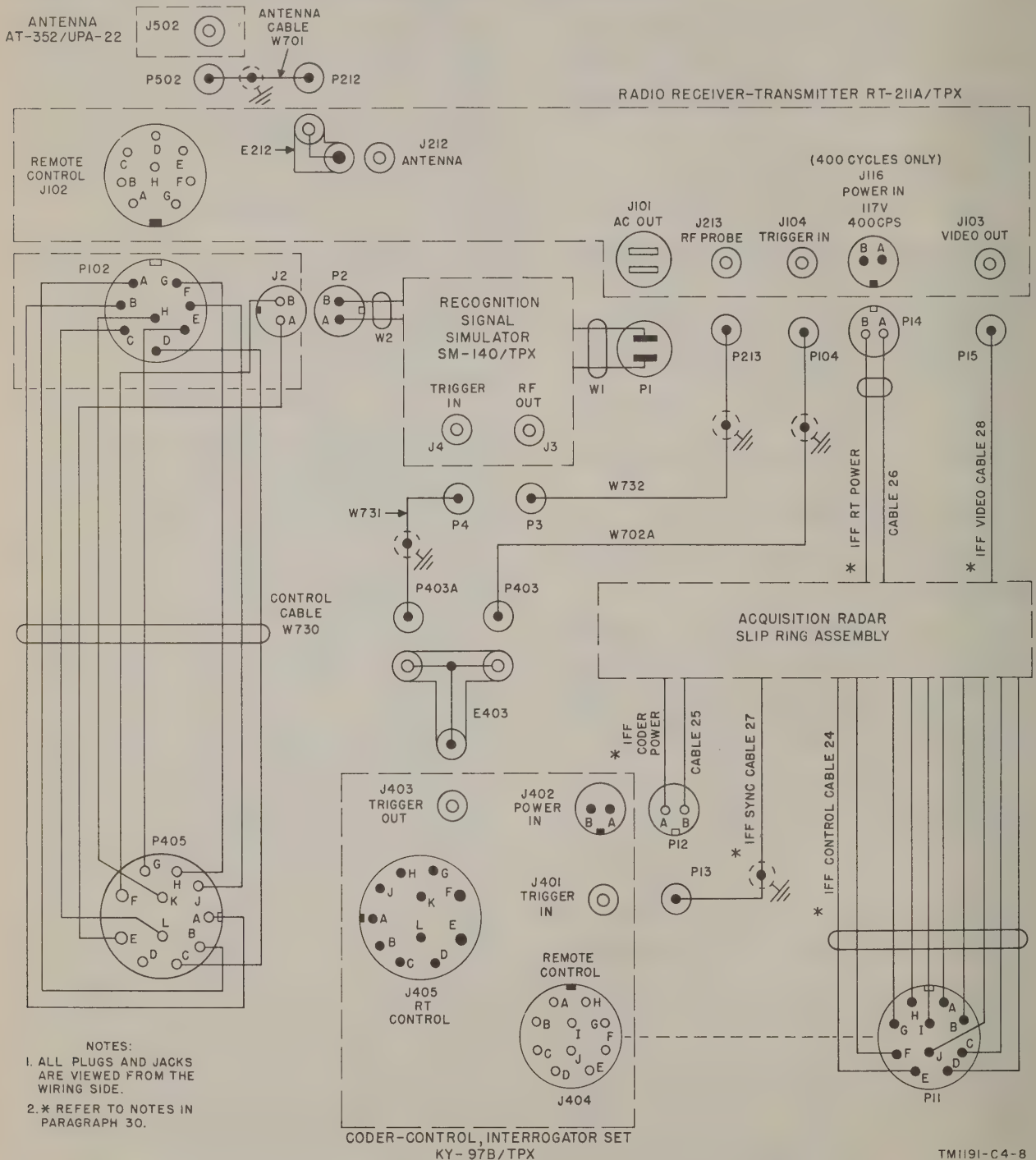

Figure 8. Detailed wiring diagram of interconnecting cables and cords for Interrogator Set AN/TPX–27.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Antenna cable W701	Connected from the receiver-transmitter to the IFF antenna T-junction filter.		
	2	Video cable W702A	Connected from the coder-control unit to the receiver-transmitter.		
	3	Control cable W730	Connected from the coder-control unit to the receiver-transmitter.		
	4	Trigger cable W731	Connected from the coder-control unit to the simulator.		
	5	Rf cable W732	Connected from the simulator to the receiver-transmitter.		
	6	Simulator cable W1	Connected to the receiver-transmitter.		
	7	Simulator cable W2	Connected to the receiver-transmitter control cable.		
	8	Ac power cable	Connected from the acquisition radar slip ring assembly to the receiver-transmitter.		
	9	Ac power cable	Connected from the acquisition radar slip ring assembly to the coder-control unit.		
	10	Sync input cable	Connected from the acquisition radar slip ring assembly to the coder-control unit.		
	11	Video output cable	Connected from the acquisition radar slip ring assembly to the receiver-transmitter.		
	12	Remote control cable	Connected from the acquisition radar slip ring assembly to the coder-control.		
	13	Receiver - transmitter POWER switch.	Set to OFF.		
	14	Receiver-transmitter GTC shorting link 0–109 (main chassis).	Removed from between jacks J111 and J112.		
	15	Receiver-transmitter GTC EXT-INT link 0–108 (main chassis).	Set to INT.		
	16	Receiver-transmitter receiver frequency dial.	Set to specified operating frequency.		
	17	Receiver-transmitter transmitter frequency dial.	Set to specified operating frequency.		
	18	Coder-control POWER switch	Set to OFF.		
	19	Coder-control DELAY IN-DELAY OUT switch (inner chassis).	Set to DELAY OUT.		

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	20	Coder-control EXT TRIGGER-SELF TRIGGER switch (inner chassis).	Set to EXT TRIGGER.		
	21	Coder-control impedance matching link 0–401 (inner chassis).	Set for 510-ohm impedance.		
	22	Coder-control CHALLENGE switch	Set to OFF.		
	23	Coder-control CHOP switch	Set to OFF.		
	24	Coder-control GTC switch	Set to LONG.		
	25	Coder-control LOCAL-REMOTE switch.	Set to LOCAL.		
	26	Coder-control MODE SELECTOR switch.	Set to MODE 2.		
	27	Coder-control RECEIVER GAIN control.	Set to position 5.		
	28	Remote control CHALLENGE switch (tracking and tactical control consoles, M33 trailer).	Released.		
	29	Remote control CHOP switch (tactical control console).	Set to OFF.		
	30	Remote control GTC switch (tactical control console).	Set to LONG.		
	31	Remote control GAIN control (tactical control console).	Set to mid position.		
	32	Remote control MODE SELECTOR switch (tactical control console).	Set to MODE 2.		
	33	Simulator POWER switch	Set to OFF.		
	34	Simulator B+ ON switch	Set to REMOTE.		
	35	Simulator TRIG IN switch	Set to MODE 2.		
	36	Simulator OUTPUT switch	Set to CODE.		
	37	Video decoder POWER switch	Set to OFF.		
	38	Decoder remote control TEST-OPERATE switch.	Set to OPERATE.		
	39	Decoder remote control MODE 2 CODE control.	Set to code 77.		
START	40	Receiver-transmitter POWER switch.	Set to ON.	Receiver-transmitter POWER indicator (E120) lights (after 60-second time delay).	Check ac power connection (cable 26) to radar slip ring assembly. Check POWER fuse F103 on the front panel; interlock switch S102 and thermostatic control S103 on the main chassis, and POWER indicator E120 on the front panel. Check connection between jacks J207 and P107 on the rf subassembly.

START				Receiver-transmitter blower B101 begins to operate (par. 40*a*, TM 11–1191).	Check wiring to blower B101. Check undertemperature thermostat S101.
				Coder-control RT POWER indicator E418 lights (after a 60-second time delay).	Check RT POWER indicator lamp E418 and the connection of cable W730 between the coder-control and receiver-transmitter.
	41	Coder-control POWER switch	Set to ON	Coder-control POWER indicator E416 lights.	Check ac power connection (cable 25) to radar slip ring assembly. Check fuse F401 on the front panel. Check POWER indicator lamp E416.
	42	Simulator POWER switch	Set to ON.		
	43	Video decoder POWER switch	Set to ON.	Video Decoder POWER indicator DS201 lights.	Check connection of power cable W737 to power cable W708. Check fuse F201 on the front panel. Check POWER indicator DS201.
	44	Coder-control LOCAL-REMOTE switch.	Set to REMOTE	RT POWER indicator E418 on the coder goes out; IFF POWER indicator (tracking console) lights.	Check indicator lamp and remote control cable 24.
EQUIPMENT PERFORMANCE	45	Remote control CHOP switch (tactical control console).	Set to ON.		
	46	Remote control CHALLENGE switch (tracking or tactical control console).	Set to ON	Receiver-transmitter and remote control box CHALLENGE indicators E121 and E701 light. A simulated reply signal appears on the radar PPI scope.	If only one indicator is lighted, check the appropriate indicator lamp; check connection of cable W730 between the receiver-transmitter and coder-control unit, and remote control cable 24 from the coder-control unit to the radar slip ring assembly.
					If the CHALLENGE indicators do not light but a simulated reply signal appears on the radar PPI scope, the coder-control unit, receiver, and decoder are operating properly and the fault is in the transmitter. Check fuses F101 (PLATE) and F102 (RELAY SUPPLY) on the receiver-transmitter. Check tubes V201 through V207 on the RF subassembly. Check tubes V115, V116, V107, V108, and V109 on the main chassis. Check power supply voltages. See that the transmitter dial is set for the desired operating frequency.

EQUIPMENT PERFORMANCE

Item No.	Item	Action or condition	Normal indications	Corrective measures
				If the CHALLENGE indicators do not light and no reply is seen on the radar PPI scope, set the simulator TRIG IN switch to the PULSE position. If the CHALLENGE indicators light and a simulated reply appears, check coder-control tubes V404, V405, and V409, and mode selector relays K401 and K402. If the CHALLENGE indicators are not lighted and no reply is seen on the radar PPI scope when the simulator TRIG IN switch is in the PULSE position, the trouble may be in the coder-control system or the radar synchronization circuit. Turn the EXT TRIGGER-SELF TRIGGER switch on the coder-control chassis to the SELF TRIGGER position. If CHALLENGE indicators light and a reply signal appears, check tubes V401 and V402 in the coder-control unit. Check connection of cable W702A between the receiver-transmitter and the coder-control unit, and connection of trigger input cable 27 from the radar slip ring assembly. Check components of the radar trigger circuit. If the CHALLENGE indicators do not light but a reply is now seen, refer to the above corrective measure immediately. If the CHALLENGE indicators are lighted but no simulated reply is seen, set the decoder remote control TEST-OPERATE switch to the TEST position. If the reply pulse train now appears, the trouble is in the video decoder. If a signal does not appear but noise is seen

				on the PPI scope (RECEIVER GAIN control set to maximum), the trouble is in the simulator. If neither signal nor noise appears, the fault is indicated in the receiver system. Check connection of video output cable 28 from receiver-transmitter to the radar slip ring assembly. Check tubes V208 and V209 on the RF subassembly; V301 through V309 and detector CR303 (or V310) on the IF amplifier subassembly; and tubes V112, V113, V110, and V117 on the main chassis. Check the radar video mixing circuit (switching and mixing unit).
				If the CHALLENGE indicators are lighted and a simulated reply is seen on the radar PPI scope, but no reply is received from a known operating transponder, check connection of cable W701 to the IFF antenna. See that all mode and code controls are properly set. Visually inspect the antenna system for abnormalities.
47	Decoder remote control TEST-OPERATE switch.	Set to TEST.		
48	Remote control GAIN control (tactical control console).	Vary control to extreme positions	Simulated IFF reply pulse train on the radar PPI scope varies in brightness in accordance with setting of control.	Check tubes V301 through V309 on the IF amplifier subchassis of the receiver-transmitter.
49	Remote control GTC switch (tactical control console).	Set to LONG	IFF reply signals clearly seen on the PPI scope.	Check tubes V112, V110, V113, V117, and relay K152 on the main chassis of the receiver-transmitter.
		Set to SHORT	IFF reply signals clearly seen on the PPI scope.	Same as above.

CHAPTER 5

THEORY OF OPERATION

Section I. INTRODUCTION

58. General. The interrogator set when employed with Decoder Group AN/TPA–3, is an IFF Mark X (SIF) interrogator system designed for operation with antiaircraft fire control system M33. The interrogator set may be operated to challenge all aircraft detected by the radar search system and will receive reply signals from aircraft properly equipped with IFF Mark X (SIF) transponder equipment. Essentially, the interrogator set consists of a receiver-transmitter (the basic radio unit required for the transmission and reception of RF challenge and reply signals) and a coder-control unit, which controls the operation of the set and regulates the interpulse spacing of the challenge signals in accordance with the coding of the IFF Mark X (SIF) system. Decoder Group AN/TPA–3, which operates in conjunction with the interrogator set, includes a video decoder for processing the IFF Mark X (SIF) reply code from the transponder, and a remote switching control unit for establishing the video decoder code settings. In addition, the M33 system provides the remote control equipment required for normal operation and the circuits necessary to coordinate the IFF operation with that of the acquisition radar.

59. Systems. *a. General.* For the purpose of describing the theory of the IFF Mark X (SIF) system, the equipment is divided into eight systems (fig. 9) which are described in *b* through *i* below; a detailed analysis of each system is given or a reference in TM 11–1191 is provided in paragraphs 60 through 72. The basic systems are identified as follows:

(1) IFF transmitter system.
(2) IFF antenna system.
(3) IFF receiver system.
(4) IFF decoder system.
(5) Radar IFF video mixing system.
(6) IFF receiver-transmitter power supply system
(7) IFF coder-control system.
(8) IFF remote control system.

b. IFF Transmitter System. The IFF transmitter system is mounted on the main chassis of the receiver-transmitter, which also mounts the circuits of the receiver system and the receiver-transmitter power supply system. The principal circuits of the transmitter system include a modulation group that develops hv pulses, a direct crystal-controlled exciter that generates an RF signal, and a series of cavity units that develop the RF power required for transmission. During operation, the transmitter is activated by paired trigger pulses (3-, 5-, or 8-microsecond spacing) delivered from the coder-control unit; the transmitter develops RF output pulses that bear the initial spacing (or coding) of the trigger pulses delivered from the coder. This output, which constitutes the IFF challenge signal, is delivered to the IFF antenna system for transmission to any target detected by the radar system. The transmitter system may be varied in frequency from 990 mc to 1,040 mc and has an RF peak power output of 1,500 watts minimum.

c. IFF Antenna System. Antenna AT–352/UPA–22 is connected through an RF cable and duplexing assembly to the receiver and transmitter systems in the receiver-transmitter unit. The rigid installation of the IFF antenna on the forward end of the acquisition radar antenna establishes the azimuth alinement required between the IFF equipment and the M33 system. The transmission of IFF challenge signals is therefore radiated in the same direction as the search radar signals. The IFF antenna system also provides for the reception of reply signals from friendly targets. These signals are delivered to the receiver system of the receiver-transmitter. Over the frequency range of 1,010 mc to 1,110 mc, the IFF antenna system has a horizontal radiation pattern of less than 7° at the half power points.

d. IFF Receiver System. The principal circuits of the receiver system include a direct crystal-controlled oscillator, a preselector assembly for image rejection, a crystal mixer, a 60-mc IF amplifier that incorporates antijamming circuits,

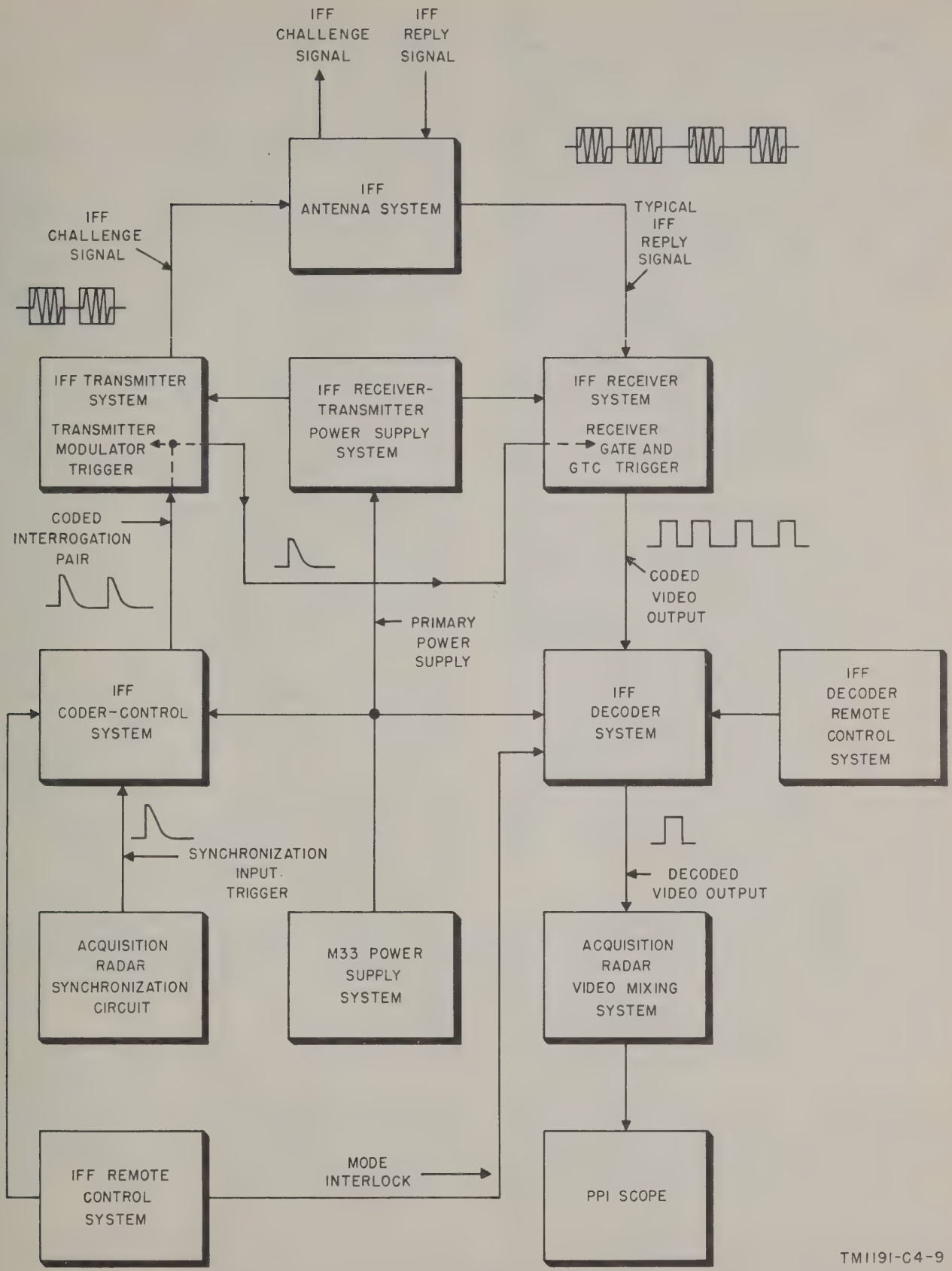

Figure 9. Interrogator Set AN/TPX-27 systems, block diagram.

and a gate and GTC circuit which may be set to vary the receiver gain for distant or nearby targets. The reception period (*on* time) of the receiver is established by the same paired trigger pulses from the coder-control system that activates the transmitter modulator circuit; this provides for reception only during those periods in which the interrogator set is transmitting challenge signals. During operation, the IFF reply signals from a target are delivered to the receiver system where they are converted into IF signals which are then detected and amplified for delivery to the decoder system. The IFF receiver system has a frequency range from 1,080 mc to 1,130 mc.

e. IFF Decoder System. The video output signal from the receiver system is delivered through the acquisition azimuth drive and RF units to the video decoder, housed in the M33 fire control trailer. The video decoder is the major component of the decoder group. It analyzes a reply signal received from the IFF receiver system to determine whether or not the signal corresponds to the code setting selected for a specific IFF challenge mode. If the signal consists of the proper pulse train configuration (coding) for a selected mode, the video decoder generates an output signal for delivery to the video mixing system of the radar set. The decoder remote switching control provides the switches and controls required to establish the code settings for the video decoder. The mode of operation (1, 2, 3) is selected by the interrogator set remote switching control system. Mode selection determines which of the three code settings will be operative.

f. Radar IFF Video Mixing System. The video output signal from the decoder system is delivered to the M33 switching and mixing unit where it is amplified and mixed with the MTI (moving target indicator) video output of the associated radar. This combined output is further amplified and delivered to the tracking and tactical control consoles where the IFF reply appears together with the radar echo and other target information on the PPI and precision indicator scopes.

g. IFF Receiver-Transmitter Power Supply System. The IFF receiver and transmitter systems utilize a common power supply system, mounted on the main chassis of Radio Receiver-Transmitter RT–211A/TPX. This system provides all filament, plate, and bias voltages required for operation of the receiver and transmitter. The primary power for the IFF equipment (117 volts, 400 cps) is provided by the M33 system through connectors on the acquisition radar slip ring assembly.

h. IFF Coder-Control Unit System. The coder-control system performs the coding functions of the interrogator set by processing triggers from the radar IFF synchronization circuit into pulse pairs of positive polarity. These pulses bear the coding, or interpulse spacing, of the three available challenge modes. The control functions of the coder-control system are of two kinds: controls that regulate the interpulse spacing, number, repetition rate, and delay interval of the selected challenge mode; and controls that regulate the performance of the receiver circuits in the receiver-transmitter. For normal operation of the interrogator set in conjunction with the associated radar, the coder-control system operates from an input of radar triggers; this permits proper synchronization of the IFF challenge signal with that of the radar search system. The design of the coder-control unit, however, provides for self-triggering of the interrogator set, if that type of operation (for testing) is required. The output of the coder-control system (the positive pulse pairs bearing either 3-, 5-, or 8-microsecond interpulse spacing for modes 1, 2, or 3, respectively) initiates the operation of the receiver and transmitter systems (*b* and *d* above).

Section II. TRANSMITTING AND IFF ANTENNA SYSTEMS

i. IFF Remote Control System. The remote controls for the IFF equipment, supplied by the M33 system, duplicate the principal operating controls of the coder-control unit and provide the mode interlock feature for the decoder system (*e* above). When properly connected to the coder-control unit (through cable connections provided at the acquisition radar slip ring assembly), these remote controls may be operated from the tactical control and tracking consoles in the fire control trailer. The operation of the IFF equipment thus can be controlled from a position convenient for viewing target information on the PPI scope.

60. Block Diagram and Theory. The transmitting system of the interrogator set is identical with that of Interrogator Set AN/TPX–20 (par.

66, TM 11–1191) with the exception of the challenge indicator group (par. 66*f*, TM 11–1191). The challenge indicator group in the receiver-transmitter provides further evidence of proper transmitter (and coder-control) operation. In addition to meeting the minimum power requirements, the RF output must be in the form of a pulse pair to light the CHALLENGE indicators (par. 61).

a. Paragraphs 67 through 82, TM 11–1191, give the stage by stage theory of the transmitting system.

b. Revised challenge indicator group theory is given in paragraph 61.

61. Challenge Indicator Group (fig. 10). This group is identical with the group described in paragraphs 83 through 86, TM 11–1191 with the exception of the additional components connected between challenge indicator amplifier V115B and level detector V116. These are the components that provide the pulse pair selectivity feature, whereby the CHALLENGE indicator lamps will light only if the transmitter output is a pulse pair meeting the proper minimum RF power requirements. The circuit functions in the following manner:

a. The amplified positive pulse which appears across plate load resistor R135 is divided between series capacitors C123 and C143, each charging to approximately half the pulse amplitude. This charge on capacitor C143, coupled through capacitor C142 to the grid of level detector V116, is insufficient to overcome the 22-volt bias on the tube. At the end of the pulse, when the plate voltage of V115B begins to drop, diode CR105 prevents the voltage on capacitor C143 from following the drop, and the capacitor begins to discharge through resistor R180. If only one pulse of the challenge pair is present, the capacitor will complete its discharge before the next trigger is delivered from the coder-control unit and the above sequence of events will recur. The CHALLENGE indicator lamp will not light, even though the one pulse was of the proper power.

b. If, however, both pulses of the challenge signal are present, capacitor C143 will not have sufficient time to discharge before the second pulse (3, 5, or 8 μsec later) appears. This pulse will also divide between the two capacitors, adding an additional charge to capacitor C143. If the second pulse also was above the minimum power

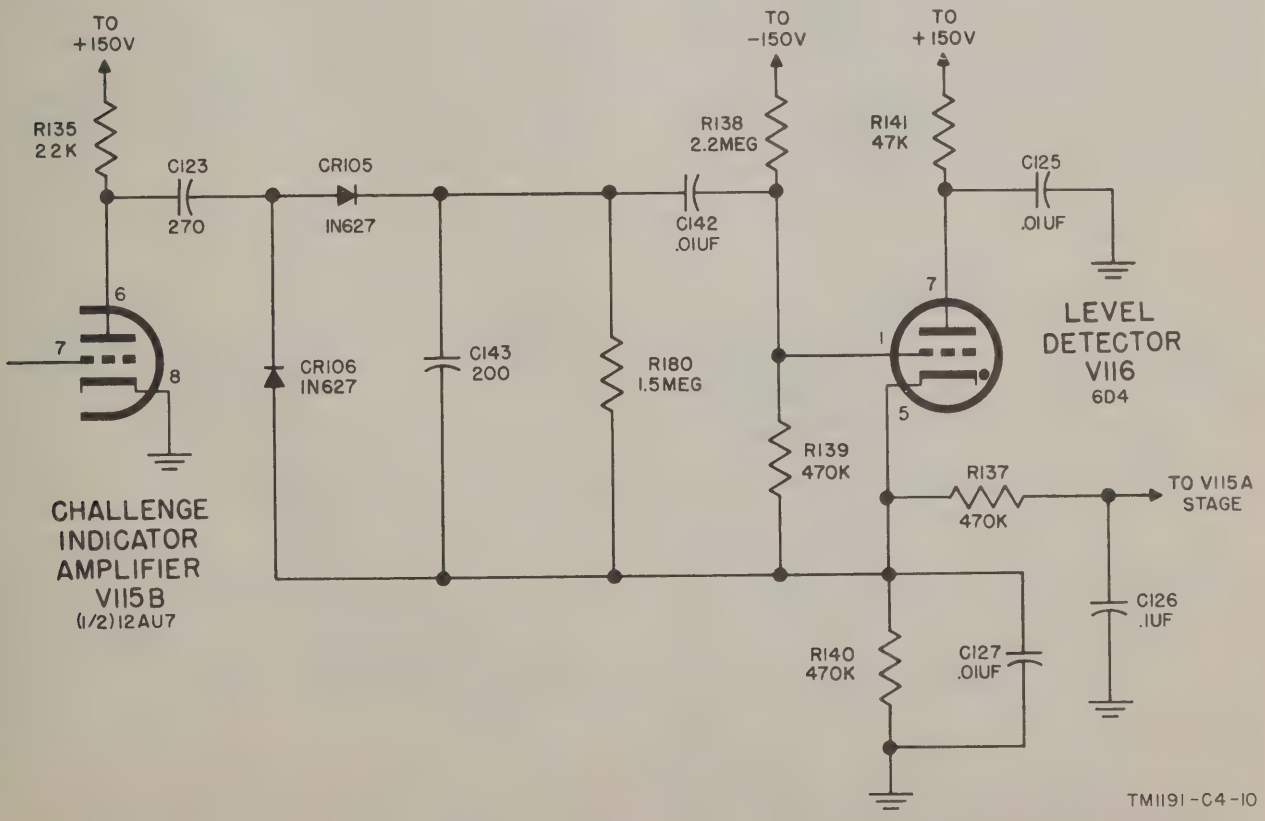

Figure 10. Challenge indicator, Radio Receiver-Transmitter RT–211A/TPX, simplified schematic diagram.

required, the combined charge will now be sufficient to overcome the bias on V116, and the process described in paragraphs 85 and 86 TM 11–1191 will take place, lighting the CHALLENGE indicator lamps.

c. Diode CR106 clamps the circuit to the cathode potential of V116, prevents capacitor C123 from swinging negative when the plate voltage of V115B drops, and thus assures that the circuit operation always begins at the same dc level for each pulse pair that is applied.

62. IFF Antenna System Theory. Paragraphs 88 and 89, TM 11–1191, explain the theory of the antenna system. Detailed theory of the antenna is given in the technical manual for Antenna AT–352/UPA–22 which is packed with each interrogator set. The antenna is mounted on the boom of the search radar set to provide azimuth alinement of the IFF and search radar system. The antenna is designed to give vertically polarized waves over a frequency range of 1,010 mc to 1,110 mc for transmission and reception of IFF signals.

Section III. RECEIVING SYSTEM

63. Block Diagram and Theory. With the exception of the video output stage, the receiving system of the interrogator set is the same as that used in Interrogator Set AN/TPX–20. A block diagram discussion is given in paragraph 90, TM 11–1191, a complete stage by stage discussion is given in paragraphs 91 through 111, 113 through 117, TM 11–1191, and the video amplifier stage is given below (par. 64).

64. Output Video Amplifier (fig. 11). The signal is coupled from the plate circuit of the first video amplifier to the control grid of video output amplifier V309. Crystal diode CR301 clamps the input circuit at zero, which allows only a positive signal to be applied to the input. Crystal diode CR304 limits the positive amplitude of the input signal, and this positive limit is adjusted by the wiper arm (limiting control) of R325. When the input amplitude reaches the level set by the limiting control, diode CR304 conducts and thus prevents any further increase of the input signal amplitude. Resistor R324 is the grid return resistor, potentiometer R325 is the cathode bias resistor, and capacitor C326 is the cathode bypass capacitor. The output is coupled through video output transformer T302 for impedance matching and to obtain the proper output polarity. Crystal diode CR305 couples the output of T302 to jacks J304, T114, and to VIDEO OUT J103. The diode decreases the recovery time of transformer T302 to accommodate the pulse train video signal used in the IFF Mark X (SIF) system. The video output of the receiver is cabled from VIDEO OUT jack J103 through the antenna slip ring assembly to VIDEO INPUT of the video decoder.

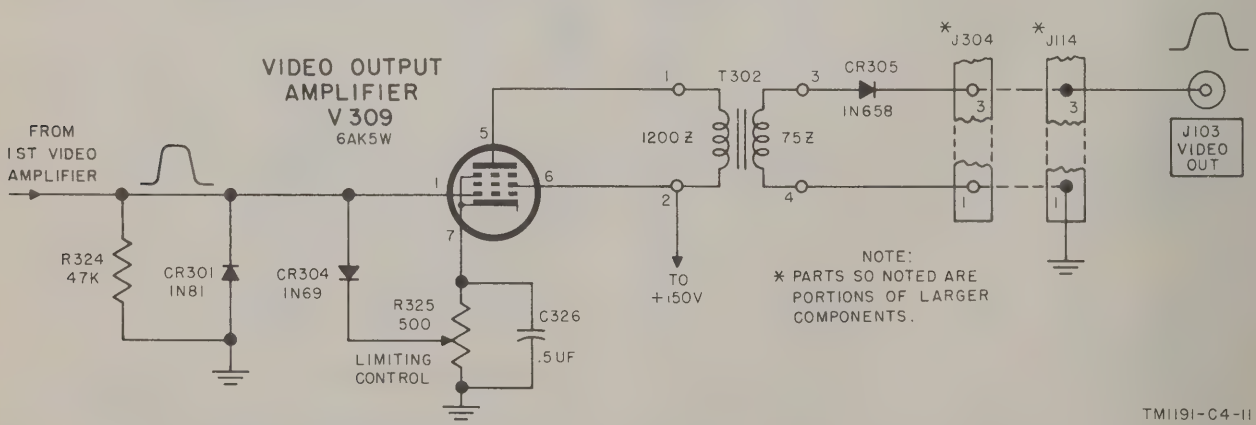

Figure 11. Video output amplifier (AM–761A/TPX), simplified schematic diagram.

Section IV. DECODER SYSTEM

65. General. The video output of the interrogator set receiver system is delivered to Decoder Group AN/TPA–3. Here the signal is analyzed for conformity with the tactical reply code established. If the requirements of this code are met the decoder produces a single video pulse output for delivery to the radar video mixing circuit. The detailed theory of operation of the decoder group is given in TM 11–5840–202–20 Decoder Group AN/TPA–3. A general discussion of this equipment is given in this technical bulletin.

66. Decoder Group Operation. *a.* The decoder produces a single-pulse output for each coded pulse train received from the IFF receiver, provided that the pulse train received corresponds with the preselected code settings. When the video decoder has been set for a particular code, it will accept the reply only if the pattern of pulses in the reply train corresponds exactly with the pattern of pulse positions of the code selected.

b. The video decoder is controlled in part at the remote switching control, and in part by controls external to the decoder group. The code settings for the various modes of operation are established at the remote switching control. The mode of operation is selected at the interrogator set remote controls of the associated radar equipment. Mode selection determines which of the three code settings will be operative. A switch at the remote switching control permits the video decoder to be entirely bypassed, when required, for certain tactical applications or for system troubleshooting.

Section V. RADAR IFF VIDEO MIXING SYSTEM AND RECEIVER-TRANSMITTER POWER SUPPLY SYSTEM

67. Video Mixing System, General. Upon application of the video pulse train to the video decoder, provided that the pulse train is of the proper coding, a single pulse reply for each pulse train is developed in the video decoder and applied to the video mixing circuits of the associated search radar system. The IFF video is mixed with the target video and marker information for presentation on the radar precision and PPI indicators.

68. Theory. Paragraphs 118 and 119, TM 11–1191, discuss the radar IFF mixing system. For detailed theory of these circuits, refer to the technical manual for the associated radar system.

69. Power Supply System. The primary power, 117 volts, single phase, 400 cps, is supplied by the fire control radar system through the slipring assembly. Paragraph 120, TM 11–1191, gives a block diagram discussion of the receiver-transmitter power supply system. Paragraphs 121 through 150, TM 11–1191, give the detailed theory of this system.

Section VI. CODER-CONTROL UNIT SYSTEM AND REMOTE CONTROL SYSTEM

70. Block Diagram and Theory. Paragraph 131, TM 11–1191 gives a block diagram discussion of the coder-control system. Because of the additional output power required of the transponders in the IFF Mark X (SIF) system, the countdown circuits of Interrogator KY–97B/TPX reduce the IFF interrogations (challenges) to a range of 100 to 300 challenges (pulse pairs) per second. Paragraphs 132 through 158, TM 11–1191, give a detailed theory discussion of the coder control unit system. The following exceptions (par. 71) apply to the Coder-Control Interrogator Set KY–97B/TPX.

71. Chop Circuit. *a.* The chop circuit is connected to the simulator through control cable W730 and simulator B+ control cable W2. When the simulator B+ ON LOCAL-REMOTE switch is in the REMOTE position, activation of the chop circuit (by placing the CHOP switch to ON from either the coder-control or the remote controls, depending on the setting of the Coder-control LOCAL REMOTE switch) will simultaneously apply plate voltage to the simulator stages.

b. In figures 97, 98, and 99, TM 11–1191, capacitor C410 in all models of Coder-Control, Interrogator Set KY–97B/TPX is 2,700 $\mu\mu$f instead of 820 $\mu\mu$f. Pins 1 and 7 of the relay socket are wired to pins E and F, respectively, of RT CONTROL jack J405 (fig. 159, TM 11–1191 and fig. 14 of this bulletin). These in turn are

connected through control cable W730 to J2 at the other end to which simulator B+ control cable W2 is attached (fig. 8). Energizing the chop relay also energizes the B+ control relay in the simulator through this connection and thus provides control of simulator operation from the remote controls.

72. Remote Control System, Operating Control. Paragraphs 159 and 160, TM 11–1191, give the IFF operating controls and indicators in the M33 fire control trailer. For the interconnection between the remote control system and the decoder group, refer to the technical manual for the fire control system.

CHAPTER 6

TROUBLESHOOTING AND REPAIR

Section I. INTRODUCTION AND PRELIMINARY INFORMATION

73. General. An introduction to the troubleshooting of Interrogator Set AN/TPX–20, which also applies to the AN/TPX–27 and the IFF Mark X system, is discussed in paragraphs 161 through 164, TM 11–1191. Preliminary troubleshooting information is covered in paragraphs 165 through 181, TM 11–1191.

a. Figure 12 of this bulletin shows the added components of figure 114, TM 11–1191.

b. In figure 117, TM 11–1191, capacitor C329 is removed and R330 is replaced by diode CR305 (fig. 20).

c. Table XXIII, paragraph 175, TM 11–1191 lists the germanium and silicon diodes used in the equipment. The following diodes are also used.

Component	Type	JAN No.	Function	Location
CR105	Silicon	1N627	Charging	Main chassis.
CR106	Silicon	1N627	Clamping	Main chassis.
CR305	Silicon	1N658	Recovery	IF strip.

74. Test Cable Connections. To make the receiver-transmitter and coder-control unit accessible for troubleshooting, follow the test cabling instructions given below.

***Caution:* Before proceeding with the instructions in *a* and *b* below, turn off the IFF equipment and the battery acquisition radar system.**

a. Receiver-Transmitter. Follow the procedure to service or test the receiver-transmitter under operating conditions.

(1) Disconnect the simulator control cable W2 from the receiver-transmitter control cable W730. Disconnect the control cable (W730), power cable (#26), antenna cable (W701), and video cable (#28) from the receiver-transmitter (fig. 4).

(2) Reach behind the coder-control unit and disconnect T-connector E403 (fig. 4) from the TRIGGER IN jack at the bottom of the rear panel.

(3) Release the captive screws on the front panel of the receiver-transmitter and remove the main chassis from the dust cover. Place the chassis on a suitable level area (or work bench) at the base of the antenna pedestal.

(4) Pull interlock switch S102 on the main chassis (fig. 9, TM 11–1191) as far to the rear as possible.

(5) Connect straight connector P405B on one end of extension control cable W703B to right-angle connector P102 on control cable W730 (the other end of W730 remains connected to the coder-control unit). Connect right-angle connector P102B on the other end of W730B to REMOTE CONTROL jack J102 on the front panel of the receiver-transmitter.

Note. Extension control cable W703B does not provide a continuation of the control leads for the simulator. To operate the simulator under these conditions, set the B+ ON switch to the LOCAL position. Refer to the simulator technical manual for complete operating instructions.

(6) Connect the male connector on one end of extension video cable W702B to the TRIGGER IN jack on the coder-control unit. Connect the female connector on the other end of the cable to the center male receptacle of T-connector E403.

(7) Connect Electrical Power Cable Assembly CX–1601/TPX (item 9, fig. 7, TM 11–1191) to POWER IN jack J116 on the front panel of the receiver-transmitter, and plug the other end into convenience outlet J5 or J23 on the radar antenna pedestal assembly.

(8) Connect POWER ATTENUATOR AND DUMMY LOAD Z502 or Radar Test Set AN/UPM–6A or AN/UPM–6B to adapter E212 at ANTENNA jack J212, as required.

(9) The only operating connection not reconnected now is the video cable from VIDEO OUT jack J103. If radar test equipment is used, this connection will be made to the radar test set by a cable assembly provided with the test equipment.

Caution: **Before the radar set is turned on, be sure that the antenna drive switch on the radar antenna assembly is turned to the OFF position.**

b. Coder-Control Unit. Use the following procedure to service or test the coder-control unit under operating conditions. Before proceeding with these instructions, disconnect the cable connections to the receiver-transmitter and remove the main chassis of that unit as described in *a* above.

(1) Release the captive screws that secure the IFF mounting channels to the radar antenna assembly (fig. 22, TM 11–1191).

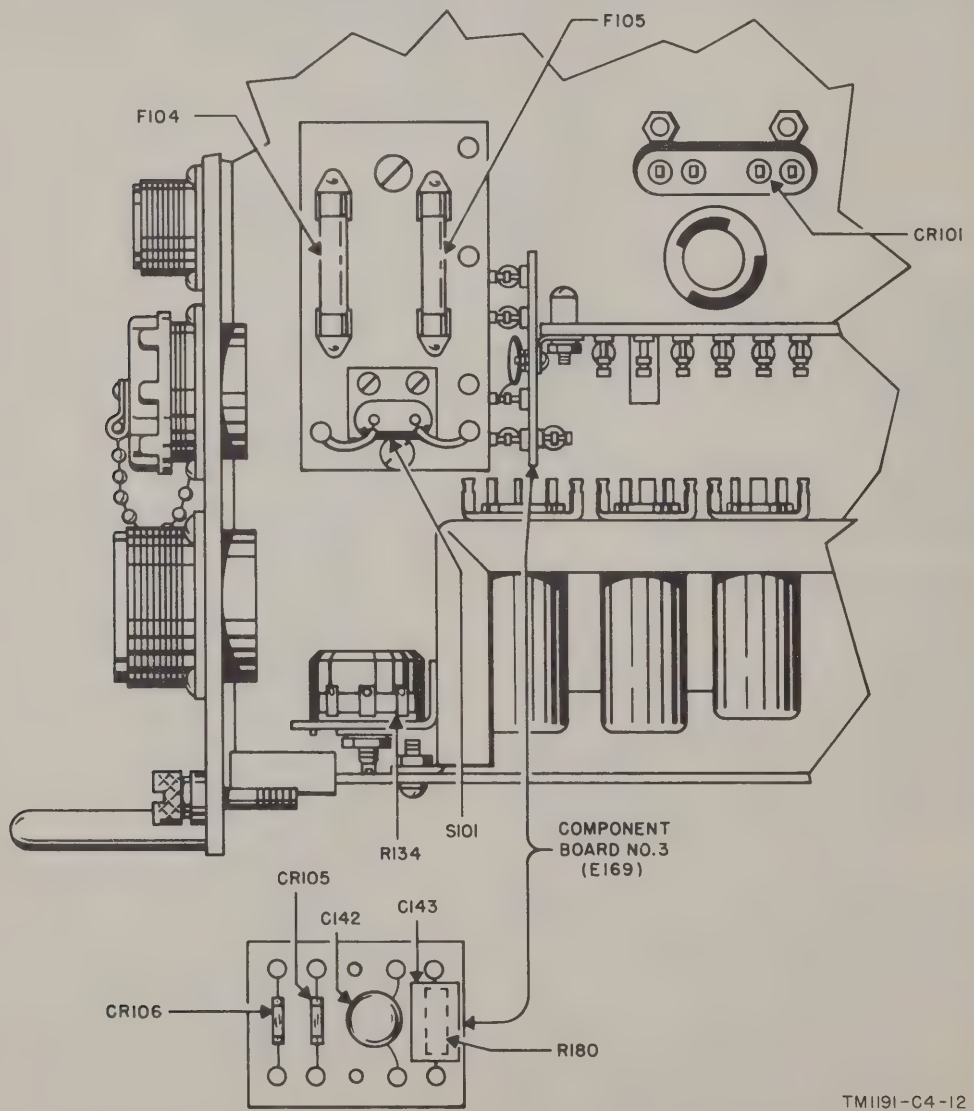

Figure 12. Components added to figure 114, TM 11–1191.

(2) Ease the receiver-transmitter dust cover out of the inclosure until the cable connections at the rear of the coder-control unit are accessible.

(3) Disconnect the three cable connections between the radar slip ring assembly and the following jacks on the coder-control unit: TRIGGER IN, REMOTE CONTROL, and POWER IN (fig. 20).

(4) Place the dust cover and coder-control unit beside the receiver-transmitter main chassis at the foot of the radar antenna assembly.

(5) Connect Electrical Power Cable Assembly CX–1601/TPX (item 9, fig. 7, TM 11–1191) to POWER IN jack J402 on the rear panel of the coder-control unit and plug the other end into convenience outlet J5 or J23 on the radar antenna assembly.

(6) Remove the louvered side panel on the coder-control unit and set the EXT TRIGGER-SELF TRIGGER switch on the chassis to the SELF TRIGGER position. (This eliminates the necessity of reconnecting the synchronization trigger cable to the coder-control unit at the TRIGGER IN jack on the rear panel.)

Note. If radar test equipment is used, keep this switch at the EXT TRIGGER position. Input triggers then can be supplied to the coder-control unit at the TRIGGER IN jack on the rear panel with a cable assembly provided with the test equipment.

(7) Set the LOCAL-REMOTE switch on the front panel of the coder-control unit to the LOCAL position. The front-panel controls of the coder-control unit now become operative. (This eliminates the necessity for reconnecting the remote control cable to the coder-connecting unit at the REMOTE CONTROL jack on the rear panel.)

(8) The coder-control unit now can be serviced or tested under operating conditions without making further connections.

(9) If the receiver-transmitter and coder-control unit are to be tested together, reconnect T-connector E403 (with trigger cables W702A and W731 attached) to the coder-control TRIGGER IN jack J403 and control cable W730 to the receiver-transmitter REMOTE CONTROL jack J102. Connect POWER ATTENUATOR AND DUMMY LOAD Z502 or Radar Test Set AN/UPM–6A or AN/UPM–6B to adapter E212 at ANTENNA jack J212, as required. Supply power to the receiver-transmitter as described in *a*(8) above.

(10) When replacing the IFF equipment in the radar antenna assembly, follow the applicable portions of the installation instructions given in paragraphs 25 through 28. Make sure that the coder-control unit EXT TRIGGER-SELF TRIGGER switch has been set to the EXT TRIGGER position before the unit is installed. Set the LOCAL-REMOTE switch on the coder-control unit to the REMOTE position.

75. Changes to Schematic Diagram. The following chart lists the schematic and wiring diagrams of the components of Interrogator Set AN/TPX–20 and the changes to these schematic diagrams for Interrogator Set AN/TPX–27.

Schematic or wiring diagram	TM 11–1191 fig. No.	Diagrams in this technical bulletin fig. No.
Receiver-transmitter wiring diagram	158	13
Coder-control unit, wiring diagram	159	14
IF amplifier strip, schematic diagram	161	15
Receiver-transmitter main chassis, schematic diagram	163	16
Receiver system, schematic diagram	164	17
Transmitting system, schematic diagram	165	18
Coder-control unit system, schematic diagram	167	19
Receiver - transmitter, overall schematic diagram	168	20

Section II. TROUBLESHOOTING BASED ON STARTING PROCEDURE

76. Introduction. Paragraphs 182, 183, and 184, TM 11–1191, introduces and prepares the repairman for troubleshooting based on starting procedure. Because of the difficulty encountered when troubleshooting the interrogator in its operating position, provisions have been made, using test cables, to remove the equipment from the antenna pedestal for testing and troubleshooting. Paragraph 34, TM 11–1191, and the test cabling instruction in this technical bulletin (par. 33) give the proper connections for testing and troubleshooting.

77. Troubleshooting Chart. *a.* For troubleshooting based on starting procedure, proceed with the steps beginning on page 176, TM 11–1191; note the following exceptions.

b. Under note in step 1, item 4, the interconnecting cable is numbered W730 instead of W703.

c. Disregard step 3, page 177, TM 11–1191. Use step 3 given below.

STEP 3. Set the CHALLENGE switch on the remote control panel (tactical control console or tracking console) to ON. (Allow 60 seconds to elapse between step 1 and step 3 to permit proper operation of time-delay relay.)

Normal indication: 1. CHALLENGE indicator lamp on the front panel of the receiver-transmitter lights.
2. CHALLENGE indicator lamps on the tactical control console and tracking console light.

Abnormal indication	*Probable location of fault*
1. CHALLENGE indicator lamp on the front panel of the receiver-transmitter lights, but the CHALLENGE indicator lamps on the tracking console and tactical control console do not light.	1. Check receiver-transmitter and remote control indicator lamps. *Note.* The CHALLENGE indicator lamps are wired in parallel through switch S402 on the coder-control unit. If one indicator lamp is lighted, and the other is not, the fault is probably in the indicator lamp or in cable W730.
2. CHALLENGE indicator lamps on the tracking console and tactical control console light, but the receiver-transmitter CHALLENGE indicator does not light.	2. Check indicator lamp E121 on the receiver-transmitter.
3. CHALLENGE indicator lamps do not light on either the receiver-transmitter or the tracking console and the tactical control console.	3. Operate the simulator in accordance with the instructions in paragraph 43. If a reply appears on the radar PPI scope the coder-control and receiver systems are operating normally, and the fault is indicated in the transmitter system. Refer to paragraph 232, TM 11–1191 and check the transmitter power output; use Radar Test Set AN/UPM–6A or –6B. If the transmitter output power is below 400 watts, refer to the transmitter troubleshooting chart in paragraph 189, TM 11–1191. If the power output is above 400 watts, check the challenge indicator network; use the test procedure outlined in paragraph 193, TM 11–1191.
	If no signal appears on the radar PPI scope, place the simulator TRIG IN switch to PULSE. If a simulated reply signal now appears, the transmitter is not receiving the proper pulse-pair challenge triggers, and the fault is indicated in the coder-control unit.
	If the reply signal still is not obtained, a fault may also be indicated in either the radar trigger output circuit or the coder-control unit system.
	To ascertain which system is involved, turn EXT TRIGGER-SELF TRIGGER switch S401 on the coder-control unit chassis to the SELF TRIGGER position. If a reply now appears on the PPI scope,

Abnormal indication	*Probable location of fault*
	check tubes V401 and V402 in the coder-control unit, and the output at P13 of IFF sync cable 27 (from the slip ring assembly). If the reply signal is not seen on the PPI scope, check tubes V403 through V410 in the coder-control unit, trigger cable W702A, and the output at TRIGGER OUT jack J403 on the coder-control unit; use the basic procedure given in paragraph 201, TM 11–1191. (Substitute the appropriate jack number as required.) The reading at the IFF sync jack should be greater than 5 volts; the reading at the coder-control unit TRIGGER OUT jack should be greater than 30 volts. If the proper output is not received from the radar IFF sync jack, refer to paragraph 209, TM 11–1191. If the proper output is received at the IFF sync jack, but not at the coder TRIGGER OUT jack, refer to paragraph 204, TM 11–1191 symptom B, for troubleshooting in the coder-control unit system.
4. CHALLENGE indicator lamps on the receiver-transmitter and tactical control console and tracking console are lighted, but no reply signal is seen on the PPI scope when the simulator is operated in accordance with the instructions in paragraph 43 and the RECEIVER GAIN control is set to maximum.	4. Place the decoder remote control TEST-OPERATE switch to the TEST position. If the simulated reply signal appears on the PPI scope, the trouble is in the video decoder. Refer to the decoder technical manual for troubleshooting in this unit. If no signal appears but noise is visible on the PPI scope, the trouble is in the simulator. Refer to the appropriate technical manuals to troubleshoot this unit. If neither signal nor noise appears, check connection of IFF video cable 28 (fig. 4) from the receiver transmitter to the slip ring assembly. If the cable is not at fault, a failure is indicated in the receiver system. Refer to paragraph 196, TM 11–1191, symptom A.
5. CHALLENGE indicator lamps are lighted and a reply signal is received from the simulator, but no reply signal is received from a known operating transponder.	5. Check connection cable W701 to ANTENNA jack. Check to see that the transmitter and receiver crystal and dial settings conform to correct operating frequencies, and that the mode and code settings are correct. If the fault is not traced to one of these causes, check the IFF antenna system. Refer to the antenna instruction literature. *Note.* If it is suspected that the receiver system is not properly alined, refer to the receiver sensitivity test given in paragraph 235, TM 11-1191. If a fault is indicated in the receiver preselector, replace the preselector assembly, or realine the preselector (par. 218, TM 11-1191).

Section III. TROUBLESHOOTING BASED ON IFF PRESENTATION AND IN TRANSMITTING AND RECEIVING SYSTEMS

78. Sectionalization, Using IFF Presentation. Paragraphs 185 and 186, TM 11–1191, sectionalize troubles that would be presented in the IFF presentation on the PPI indicators. Information in addition to the references above is contained in the manuals for the decoder Group AN/TPA–3 and Recognition Signal Simulator SM–140/TPX.

79. Troubleshooting in Transmitting System. Paragraphs 187 through 193, TM 11–1191, give troubleshooting information for the transmitting system. In addition to the requirements for lighting the CHALLENGE indicator lamp given in step 8 (par. 189), the challenge signal must be a pulse pair as well as the proper output power.

This also applies to the modulator when checking the modulator input and output. Refer to paragraph 183, TM 11–1191, and step 3 (par. 77) of this technical bulletin for the preliminary troubleshooting procedures.

Warning: **Voltages sufficiently high to cause death are exposed at many points in the transmitting and receiving systems. Do not make any connections while the voltage is applied. Always ground high-voltage capacitors before touching them or their associated circuits. Dangerous voltages are retained by the large capacitors for a considerable time after the power has been removed. Do not touch any of the circuit elements while power is applied. Discharge all high-voltage capacitors after power has been removed before performing troubleshooting or repair procedures.**

80. Troubleshooting and Reference Data. Paragraphs 194 through 201, TM 11–1191, provide receiving system troubleshooting information; additional considerations are given below. The receiver circuits are ready for operation when POWER switch is set to ON. The receiver begins its reception period when it is triggered, simultaneously with the transmitter, by the circuits actuated by the CHALLENGE switch on the tactical control (or tracking) console as described in step 3, paragraph 69. When troubleshooting the receiver, connect the equipment as specified in paragraph 33. Be sure that the ANTENNA DISABLING SWITCH on the radar antenna assembly is set to the OFF position.

a. Paragraph 196, TM 11–1191, provides a receiver troubleshooting chart. Before considering symptom A and before troubleshooting the receiver, be sure that the video decoder is functioning and the video cables are properly connected. For troubleshooting this equipment, refer to the technical manual for the Decoder Group AN/TPA–3.

b. Symptom D of paragraph 196, TM 11–1191, does not apply unless the video decoder remote control TEST-OPERATE switch is in the TEST position. With the TEST-OPERATE switch in the TEST position the video decoder is bypassed.

c. Before considering symptom E be sure that the video decoder is functioning properly. When the decoder group is connected to the receiver-transmitter, the RECEIVER GAIN control affects only the output of the receiver, and not the output of the video decoder. If the gain is set too low, the decoder will not function. Once set to provide video pulses above the decoder threshold level, the RECEIVER GAIN control will not affect the signal level, but will vary the noise seen on the PPI.

d. When performing the procedure in the troubleshooting check for auxiliary trigger output (par. 201, TM 11–1191), the CHALLENGE indicator lamp should light when the CHALLENGE switch on the front panel of the coder-control unit is switched to ON provided the transmitter power output is at a normal level and the output is a pulse pair.

Section IV. TROUBLESHOOTING IN CODER-CONTROL UNIT SYSTEM AND ALINEMENT AND ADJUSTMENT PROCEDURES

81. Troubleshooting and Reference Data. Paragraphs 202 through 210, TM 11–1191, cover the troubleshooting and repair of the coder-control unit.

82. Interrogator Set, Alinement and Adjustment. Paragraphs 211 through 230, TM 11–1191, cover the alinement and adjustment of the entire interrogator set. Paragraph 227 gives the adjustment of the countdown circuit. Because of the difference in the target transponder reply (pulse trains in the IFF Mark X (SIF) system, single pulse for Mark X IFF system) the countdown circuit should be adjusted for the lowest rate consistent with satisfactory equipment performance. This is within the range of 100 to 300 interrogations (challenges) per second.

CHAPTER 7

DISASSEMBLY AND REASSEMBLY AND CONVERSION FOR TRAVEL

83. Assembly and Reassembly Procedures. Paragraphs 238 through 248 cover the removal, replacement, disassembly, and reassembly procedures of all mechanical parts of the interrogator set. The following chart references the paragraph that gives these procedures for the various subassemblies of the interrogator set.

Component	TM 11-1191 reference (par.)		
	Removal	Replacement	Disassembly-reassembly
Transmitter coaxial cavity unit	239	240	246
Receiver preselector assembly	241	242	247
Exciter chassis	243	244	248

Additional information concerning the decoder group and simulator disassembly and reassembly is covered in the appropriate technical manual.

84. Preparation for Storage and Travel. Paragraphs 249 and 250, TM 11–1191, give the procedure for preparing the interrogator set for transportation and storage with the following exceptions:

a. The simulator power cable W1 remains connected to AC OUT jack J101. Cable W2 is to be secured by the clip on the bottom panel of the simulator.

b. For the coder-control unit (par. 250*e*), remove the louvered right side panel. Loosen the four holding screws and remove the unit from the side of the receiver-transmitter dust cover. Replace the right side panel of the coder-control unit and place the coder-control unit in the proper compartment of the transit case. Place the receiver-transmitter in the transit case. The simulator remains in place on the front panel of the receiver-transmitter.

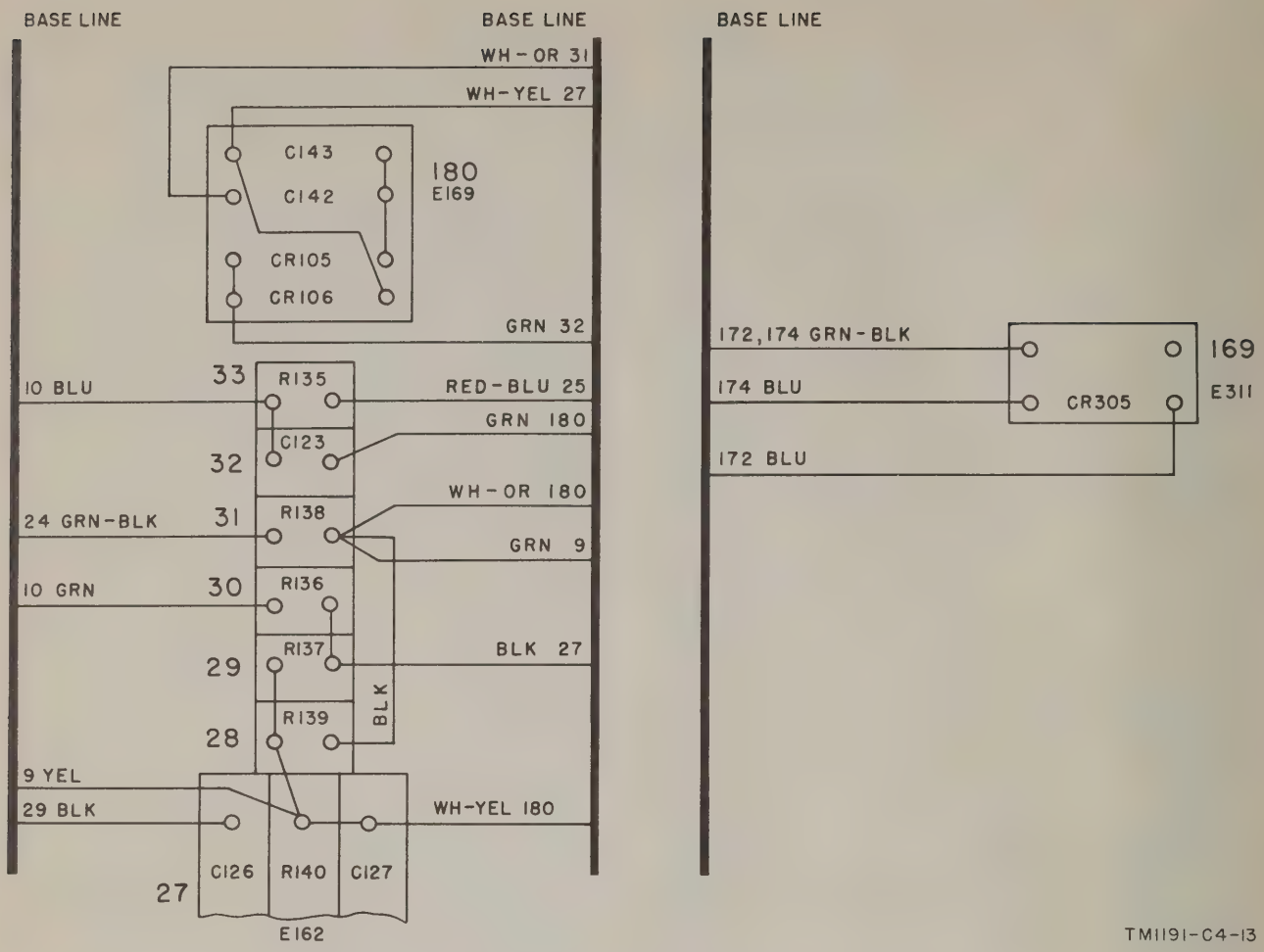

Figure 13. Detail added to receiver-transmitter wiring diagram.

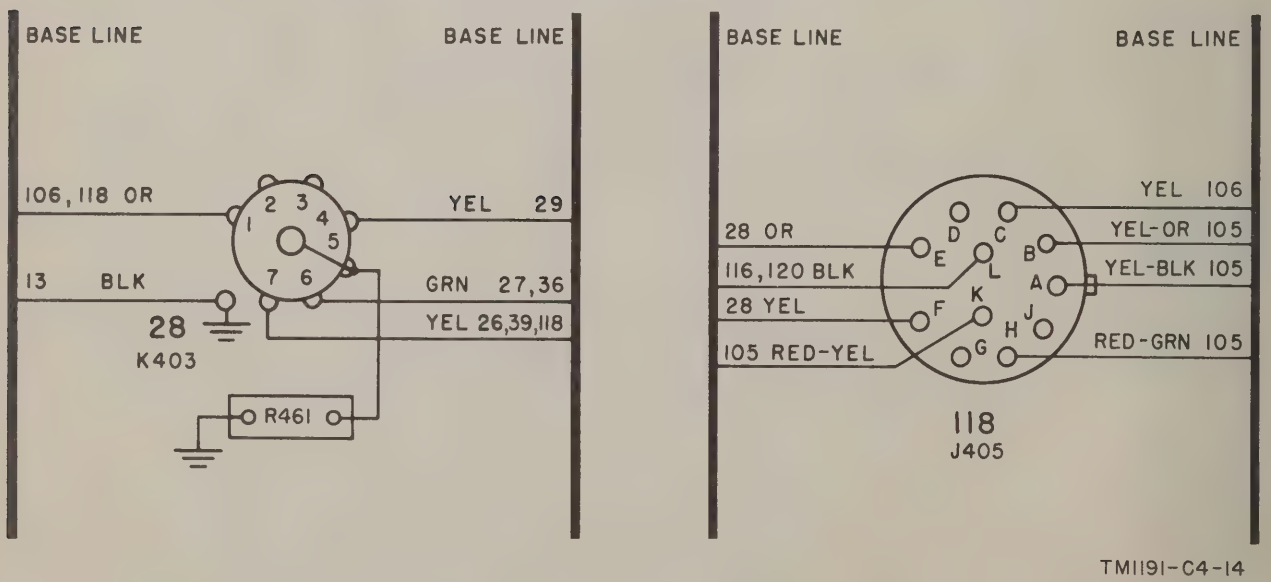

Figure 14. Detail added to coder-control unit wiring diagram.

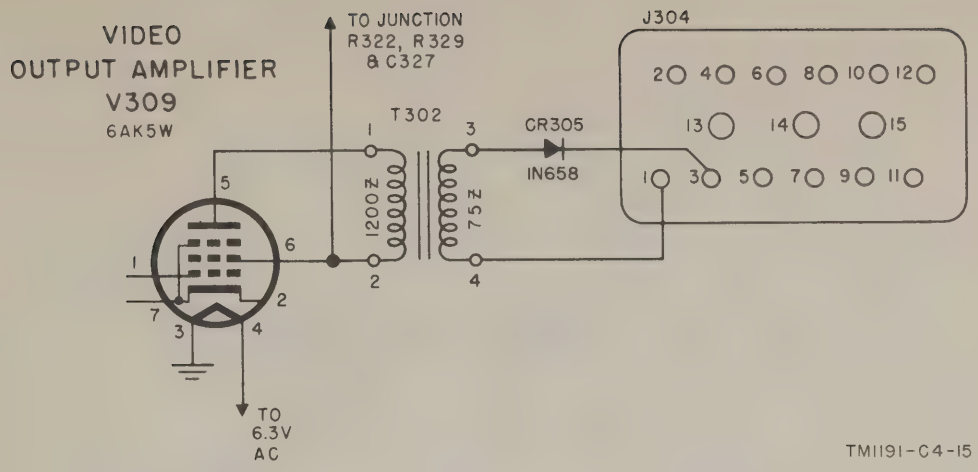

Figure 15. Detail added to IF amplifier strip schematic diagram.

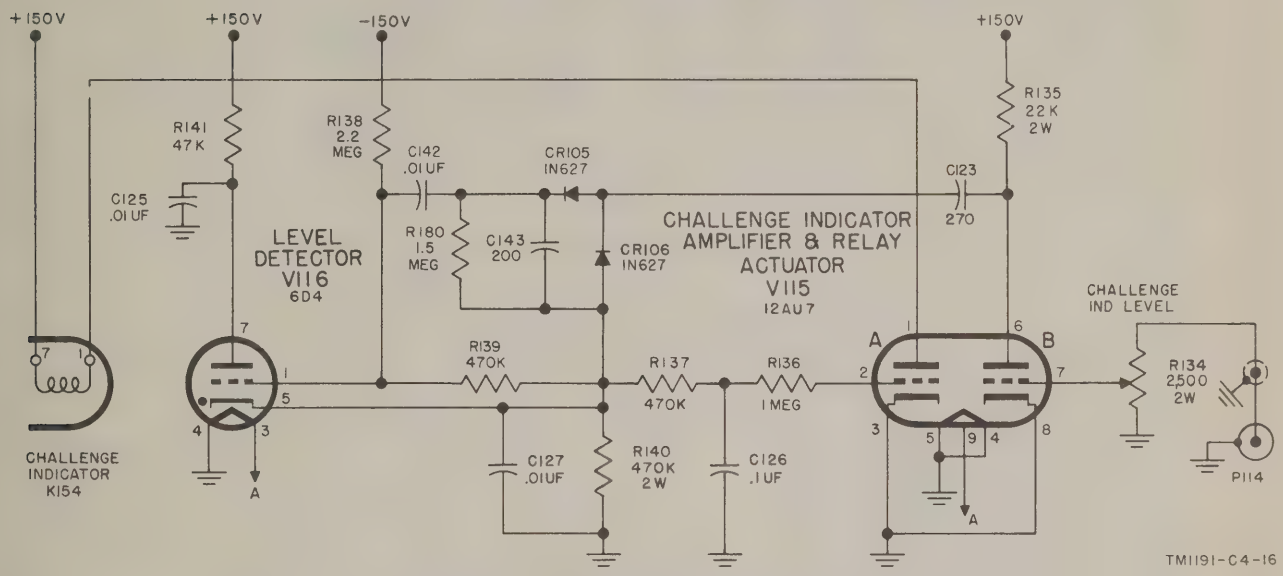

Figure 16. Detail added to receiver-transmitter main chassis schematic diagram.

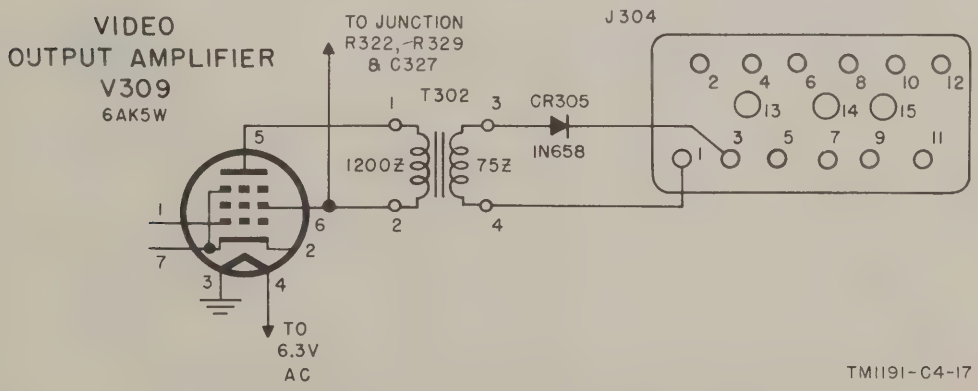

Figure 17. Detail added to receiving system schematic diagram.

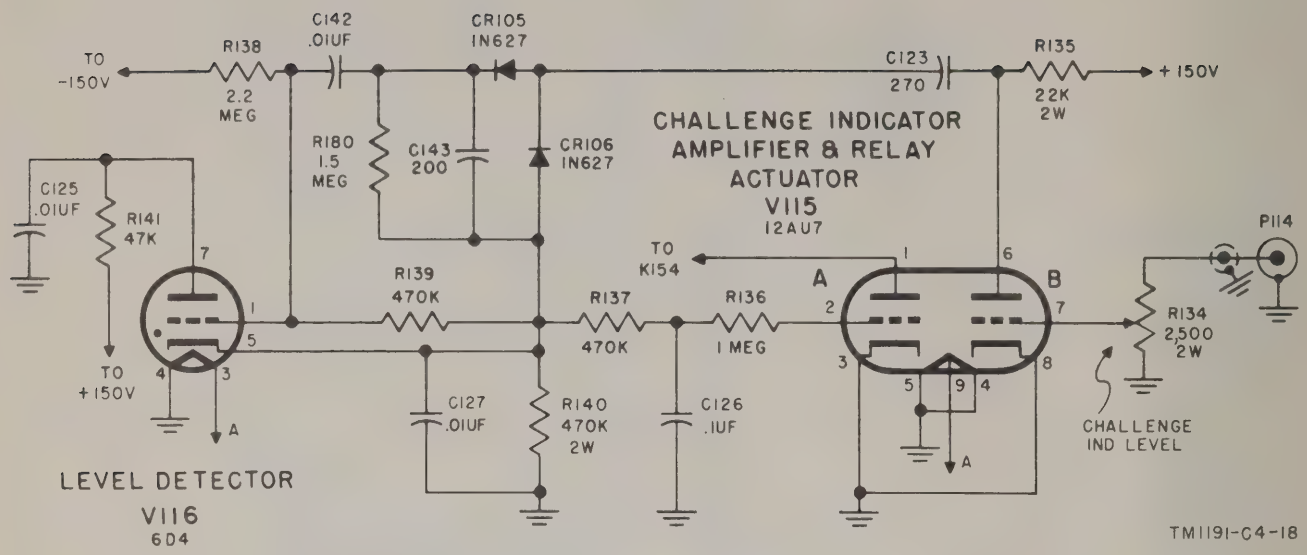

Figure 18. Detail added to transmitting system schematic diagram.

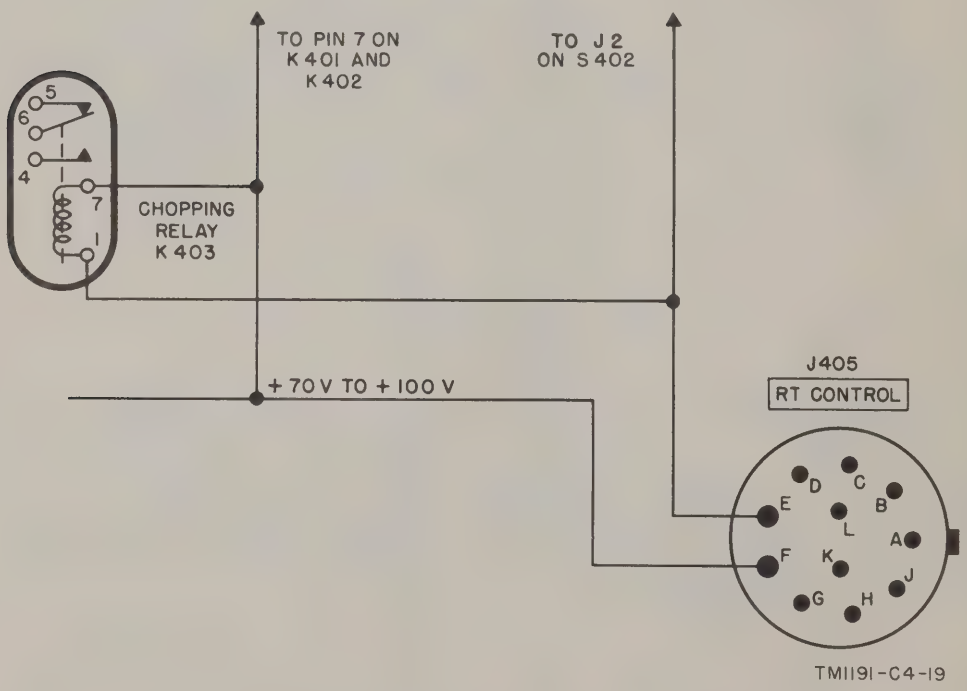

Figure 19. Detail added to coder-control unit system schematic diagram.

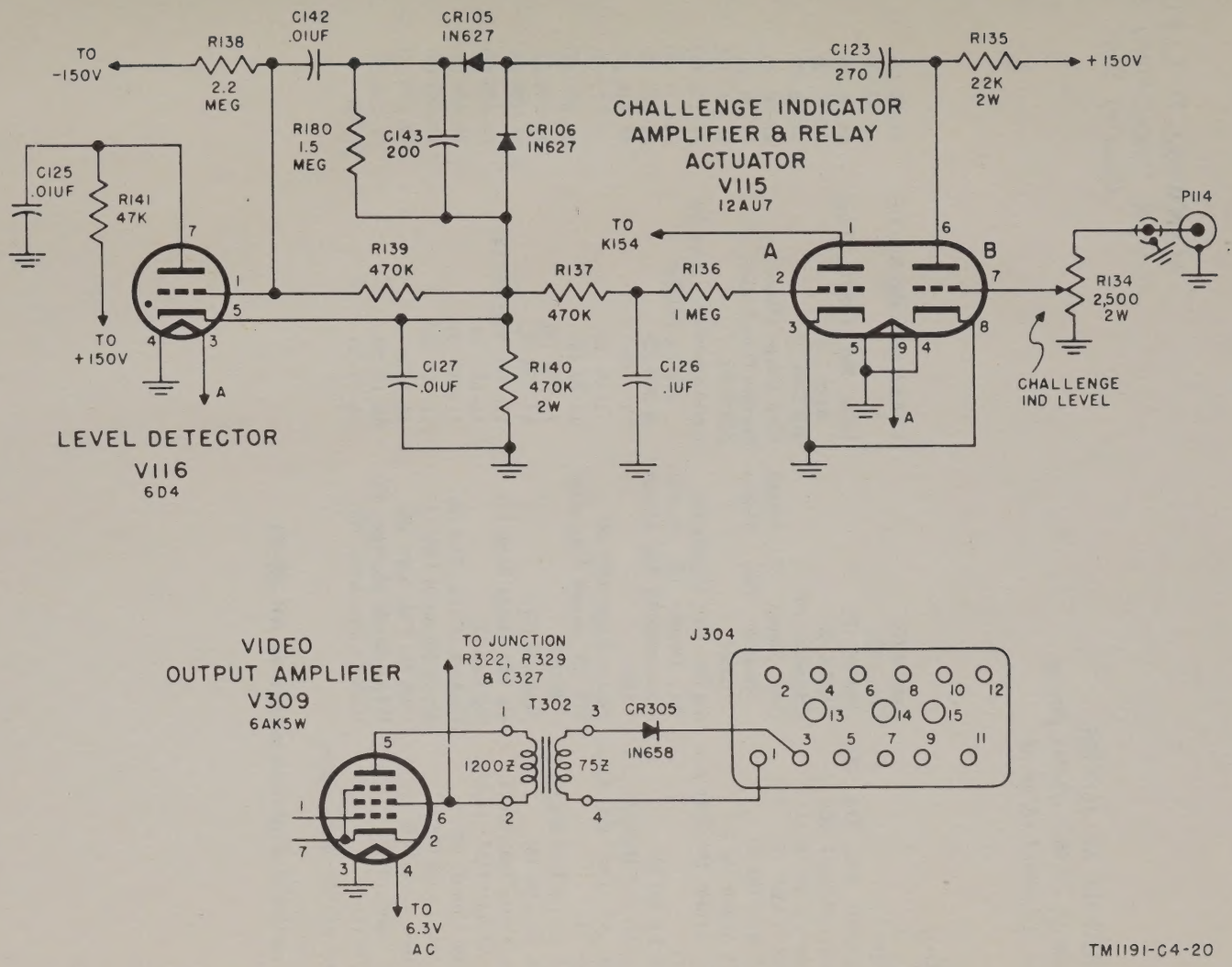

Figure 20. Detail added to receiver-transmitter overall schematic diagram.

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:
HERBERT M. JONES,
Major General, United States Army,
The Adjutant General.

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Active Army:

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CNGB (1)
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Technical Stf Bd (1)
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USA Arty Bd (3)
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USA Abn & Elct Bd (3)
USA Avn Bd (3)
USA Arctic Test Bd (2)
US ARADCOM (Incl ea Rgn Comd) (2)
OS Maj Comd (5)
OS Base Comd (5)
Log Comd (2)
MDW (1)
Armies (5)
Corps (2)
USATC (2)
USMA (2)
USASCS (10)
Gen Depot (2) except Atlanta Gen Depot (none)
Sig Sec, Gen Depots (5)
Sig Depot (5) except Sacramento Sig Depot (10)
Port of Emb (OS) (2)
PG (2) except USA Elct PG (3)
Arsenals (2)
Sig Fld Maint Shop (3)
Sig Lab (5)
USASA (Phila., Pa) (5)
Army Pictorial Cen (1)
USA Sig Pub Agcy (8)
White Sands Sig Agcy (5)
USA Comm Agcy (2)
USASA (Chicago Rgn Ofc (1)
USA Sig Comm Engr Agcy (1)
Mil Dist (1)
USA Corps (Res) (1)
Sectors Comd (Res) (1)
JBUSMC (1)
Units organized under following TOE's:
6-200 (2)
11-7 (2)
11-16 (2)
11-57 (2)
11-127 (2)
11-128 (2)
11-500 (AA-AE) (2)
11-557 (2)
11-587 (2)
11-597 (2)
44-7 (2)
44-15 (2)
44-16 (2)
44-17 (2)
44-35 (2)
44-36 (2)
44-37 (2)
44-85 (2)
44-86 (2)
44-90 (2)
44-115 (2)
44-116 (2)
44-117 (2)
44-145 (2)
44-146 (2)
44-147 (2)
44-275 (2)
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44-277 (2)
44-445 (2)
44-446 (2)
44-535 (2)
44-545 (2)
44-546 (2)
57 (2)

NG: State AG (3); units—none.
USAR: None.
For explanation of abbreviations used, see AR 320-50.